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Seed and Nitrogen Fertilizer Rates Effect on Growth, Yield and Yield Components of Irrigated Bread Wheat *(Triticum aestivum L.)* at Werer, Middle Awash, Afar Regional State, Ethiopia

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Abstract

An offseason field experiment was conducted in 2015-2016 at Werer agricultural research center, Middle Awash, Afar regional state to determine effect of seed and nitrogen fertilizer rates on growth, yield and yield components of irrigated bread wheat (Triticum aestivum L.). The experiment was conducted in a randomized complete block design (RCBD) with three replications. The treatments were factorial combination of five nitrogen levels (0, 23, 46, 69, and 92 kg N ha^{-1}) with four seed rates (75, 100, 125, and 150 kg ha^{-1}). The results of the study revealed that both main and interaction effect of N and seed rates affected leaf area, stand count, number of spikes, spikelet's per spike, spike length, grain yield, thousand grain weight, biological yield, straw yield, and harvest index, while days to 50% seedling emergence (seed rate only), days to heading, days to 85% physiological maturity, plant height, effective tillers, total tillers, and number of kernels were affected by main effect of N levels only. Maximum and minimum grain and straw yields (3724.2kg/ha; 1206.5kg/ha) and (7783.9kg/ha; 3594.7kg/ha) were obtained at 92kg N/ha with 125kg/ha seed rate, and 0kgN/ha with 75kg/ha seed rate, respectively.

Keywords: Seed rate, N fertilizer rate, Growth, Yield, Yield components.

Introduction

Wheat (*Triticum aestivum* L.) is one of the major cereal crops grown in Ethiopia that provide nourishment for the nations. Ethiopia is the second largest wheat producer in sub-Saharan Africa, after South Africa, and has favorable agro-climatic conditions for wheat production (Demeke and Marcantonio, 2013). Over 4.5 million farmers are involved in wheat production annually and about 65% of the wheat produced is of the bread wheat type, while 35% is of durum wheat type which is indigenous to Ethiopia (CSA, 2014). The estimated cultivated area under wheat is more than 1.66 million hectares with an annual production of nearly 4.2 million tons (CSA, 2014). It plays a significant role in the national economy and thus, increasing the area and productivity of this crop is central to sustainable grain production and food self-sufficiency. Moreover, it is one of the major cereals choices in Ethiopia, dominating food habits and dietary practices, and is known to be a major source of energy and protein in the country (Hailu, 2003).

Wheat is grown as a staple food in the highlands at altitudes ranging from 1500 to 3000masl with a rainfall range of between 600 to 2000mm (Hailu, 2003). An increase in the production of wheat in Ethiopia is not only through area enlargement, but also by the adoption of improved and better adapted varieties in a few bread wheat growing localities of the country.

Wheat is produced in main seasons under rain fed conditions, besides meher, belg (long, short) rainy seasons. It is also cultivated under irrigation in lowland area of Ethiopia like Middle Awash valley. However, Wheat yields in Ethiopia are relatively low due to different constraints such as socio-economic, poor agronomic practices, abiotic and biotic factors (Haile *et al*., 2012).. Particularly, in lowland areas the production of bread wheat is very low due to different factors such as lack of enough attention by farmers and other sectors, erratic rainfall distribution and poor water availability, limited modern technologies, shortage of improved varieties tolerant to the prevailing harsh environmental, and salinity problem (WARC, 2011). In recent years there is an increasing effort to produce bread wheat in low land areas of the country (middle-Awash valley) through the development of tolerant genotypes to adverse environmental condition (personal communication). Therefore, to increase the production of bread wheat under this area developing tolerant varieties, identifying best and suitable technological packages for wheat production, and increasing the participation and awareness of farmers and other sector such as different Agricultural Research center is crucial.

The use of appropriate seed and fertilizer rates are important for increasing the yield and yield components of wheat. Optimum seed rate is also a major factor in determining the ability of the crop to utilize resources and enhance yield. The growth, yield and yield components of bread wheat varieties can be affected by seed rate in different areas (Haile *et al*., 2012). Growth and yield of bread wheat are affected by environmental conditions and seeding rate (Ozturk *et al*., 2006). Among all the essential nutrients applied in the field, nitrogen is the most important for metabolic process, vegetative growth, plant productivity, protein production, and grain quality (Haile *et al*., 2012). Nitrogen fertilizer rate have a determinant effect on wheat production. Nitrogen deficiency is also the most widespread nutritional problem in irrigated wheat production in lowland areas (WARC, 2011). Presently, the production of bread wheat at Middle Awash is practiced based on blanket recommendations for seed and N-fertilizer rates for the highland. Hence, determining optimum seed and nitrogen fertilizer rates for irrigated wheat is important to increase the yield of bread wheat. Therefore, the objectives of this study were:

1. To assess the effect of seed and nitrogen fertilizer rates and their interactions on growth, yield and yield components of irrigated bread wheat variety.
2. To determine the optimum dose of nitrogen and seed rate for better growth and higher yield of irrigated wheat.

Materials and Methods

Description of the study area

The experiment was conducted in Afar Regional state at Zone three, *Amibara* district, at *Werer* Agricultural Research Center (WARC) during offseason in 2015-2016. *Werer* is located at 278 km east of Addis Ababa with an altitude of 740masl and latitudes 9° 16′N and 40° 09′ E longitude. The dominant soil type is sandy clay loam soil with particle size distribution of sand (53.75%), silt (20%) and clay (28.4 %); and a bulk density of 1.17 (WARC, 2011). The pH of the soil is slightly alkaline and ranges from 8.0-8.4. The total rainfall of the study area during the growing season (November 2015–February 2016) was 75.3 mm and the minimum and maximum temperatures were 11.9^{0}C and 35.7^{0}C, respectively.

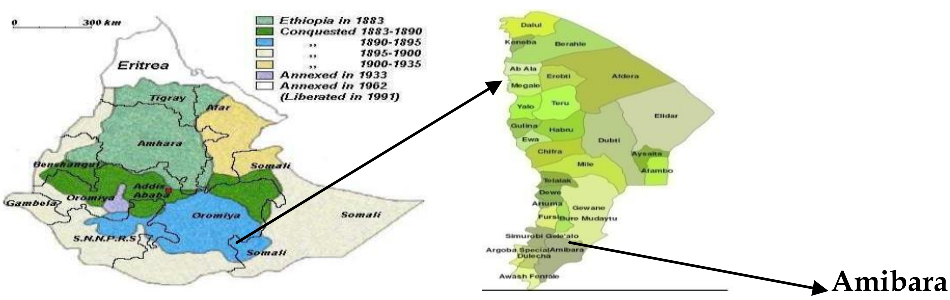

Figure 1. Location map of the study area

Experimental design and treatments

The experimental treatments were laid out in a randomized complete block design (RCBD) in three replications. Factorial combination of five nitrogen levels (0, 23, 46, 69 and 92 kg N ha^{-1}) and four seed rates (75, 100, 125 and 150 kg seed ha^{-1}) were used as treatment. Variety Fentalle/Moontiji-3, released in 2015 was used for the experiment, and sown by drilling method. Urea (46% N) and triple super phosphate (TSP) (46% P_2O_5) were used as sources of N and P, respectively. Phosphorus at 46 kg P_2O_5 ha^{-1} was applied to all plots uniformly at sowing time, and the N-fertilizer was applied in two splits: at tillering and booting stages. All other agronomic practices were undertaken uniformly as per the crop requirement for all treatments.

Soil sampling and analysis

Surface soil samples (0-30 cm) were collected from 0-30cm depth and randomly in a zigzag (diagonal) pattern before sowing and after harvesting from the entire experimental field of 20 spots. The soil samples were composited, air dried and passed through a 2mm sieve and analyzed in the laboratory for physico-chemical analysis. The soil was analyzed for total nitrogen, phosphorous, pH, OM, OC, EC, C/N and textural class. Total soil N was analyzed by Micro-Kjeldahl digestion method with sulphuric acid (Jackson, 1962). Soil pH was determined from the filtered suspension of 1:2.5 soils to water ratio using a glass electrode attached to a digital pH meter (potentiometer) (FAO, 2008). Organic carbon content was determined by the volumetric method (Walkley and Black, 1934). Texture of the soil was determined by the hydrometer method according to FAO, (2008).

Data collection

Data were collected from three phenological and fourteen yield and yield components traits. The parameters were Days to 50% seedling emergence, Days to 50% heading, Days to 85% physiological maturity, Number of total and productive tillers, Plant height (cm), Leaf area(cm^2), Stand count, Number of spikes, Spike length (cm), Number of spikelet/Spike, Number of kernels (Grain) per spike, Thousand kernel weight (TGW), Straw yield (kg/ha), Grain yield (kg/ha), Biological yield(kg/ha), Harvest index (%), and Lodging percentage.

Statistical data analysis

The data were subjected to analysis of variance (ANOVA) as per the design using statistical analysis software, version 9.1 (SAS, 2004), and interpretations were made following the procedure of (Gomez and Gomez, 1984). Where significant differences exist among the treatments mean separation was carried out using the DMRT at 5%.

Results and Discussion

Soil analysis of experimental site before sowing

The results of soil particle size distribution analysis of the experimental field indicated that the soil has a composition of sand (53.6%), clay (26.40%) and silt (21.0 %), which is categorized as sandy clay loam according to the textural triangle classification.

Table 1. Physicochemical properties of the soil before sowing and after harvest

Particle size distribution						Chemical properties						
Analysis results	**Soil depth (cm)**	**Clay (%)**	**Silt (%)**	**Sand (%)**	**Textural class**	**EC (ds/m)**	**pH (H_2O)**	**OC (%)**	**OM (%)**	**Total N%**	**C/N Ratio**	**Av.P (ppm)**
Before Sowing	0-30	26.4	21	53.6	SCL	7.15	8.06	1.32	2.22	0.17	7.7	10.42
After Harvest	0-30	30.4	19	53.9	SCL	7.3	8.4	5.1	8.7	0.6	8.9	11.5

SCL=Sandy Clay Loam; EC=Electrical conductivity; OC=Organic carbon; OM= Organic matter; TN=Total nitrogen; C/N ratio = Carbon to nitrogen ratio; Av. P = Available phosphorus

The average electrical conductivity was 7.15ds/m, which shows saline/salt/ soils. Qadir and Oster, (2004) suggested that, if EC is greater than 4ds/m the soil is classified as saline soil, which affect crop growth and finally reduce crop yield. The average pH was 8.06, which indicates a moderately basic soil reaction class. FAO (2000) reported that the preferable pH ranges for most crops and productive soils are 4 to 8. Thus, the pH of the experimental soil is almost within the range for productive soils. The organic matter and total nitrogen content of the soil, before planting were found to be 2.22% and 0.17%, respectively, which according to Charman and Roper (2007), can be described as low in nitrogen and OM. The carbon to nitrogen ratio (C/N ratio) value was 7.7, which signify a relatively high rate of mineralization and low rate of N immobilization.

The laboratory analysis results of different physicochemical properties of soil, after harvesting shows particle size distribution of the surface layers of the experimental field was dominated by sand (53.9%), clay fraction (30.4%) and 19% silt; and categorized as sand clay loam. The proportion of soil particle size after harvesting wheat differ from before sowing, clay particle increase from 26.4 to 30.4%, while sand soil had little change 53.6 to 53.9% after harvesting wheat, and silt fraction soil decreased (Table 1). Similar to soil analysis before sowing, the average of electrical conductivity (EC) of soil after harvesting was also 7.3ds/m which shows that the soil is saline. The average soil pH after harvesting was 8.4 which indicate a moderately basic reaction, which is above the range for productive soils (FAO, 2000). The average organic matter content and total N percent of the soil after harvest was 8.7 and 0.6, respectively (Table 1). The nitrogen and organic matter contents were improved and can be described as high accordingly.

The carbon to nitrogen ratio (C/N ratio) values was 8.9%, which signify a relatively high rate of mineralization and low rate of N immobilization. The available phosphorus content of the experimental area after harvest was 11.5ppm, which indicate an improvement to medium level.

The maximum (0.92 %) N concentration after harvest was recorded when 75 kg/ha seed rate and 92 N kg/ha was used, while the minimum (0.03%) N was recorded when 150 kg/ha seed rate with no nitrogen (0 N kg/ha) was used (Table 2).

Table 2. Interaction effect of N and seed rates on N concentration after harvest

	Applied N rate(kg/ha)					
	0	**23**	**46**	**69**	**92**	**Mean**
Seed rate (kg/ha)			**N% concentration after harvesting**			
75	0.04cd	0.08b-d	0.36a-c	0.77ba	0.92a	0.43
100	0.04cd	0.05b-d	0.18bc	0.55ba	0.68ba	0.30
125	0.04cd	0.04cd	0.14bc	0.39a-c	0.49ba	0.22
150	0.03d	0.04cd	0.11bc	0.39a-c	0.47ba	0.21
Mean	0.03	0.05	0.20	0.52	0.64	
SE (+)			0.4			
CV (%)			7.0			

Means followed by the same letters are not significantly difference at p<0.05.

Crop Phenology

Days to seedling emergence and heading

The main effects of N fertilizer and seed rates showed significant effect on days to heading ($p<0.05$). While, days to emergence was significantly affected by seed rate without any significant interaction effect (Table 3). The days needed for seedling emergence was increased with increasing seed rate from 75kg/ha to 150kg/ha. The highest (150 kg/ha) and the lowest (75kg/ha) seed rates took 8 days and 6 days to emerge respectively.

With increased level of applied N fertilizer from control (0N) to high (92kg/ha), the days to heading was extended from 48 to 57days (Table 4). As the level of seed rates increased from low (75kg/ha) to highest (150kg/ha), the days to heading decreased from 57.8 to 49.3 days. This could be due to the increase in competition for resources among plants, which hastened heading (Table 3). In accordance with the results of this study, IAEA, (2003) and Yang *et al*., (2000) had reported that, too little resources like N resulted in slow growth rate and hastened heading and growth, whereas high N rate kept vegetative growth active and finally resulted in delayed heading and flowering.

Days to physiological maturity

The main effect of both N fertilizer and seed rates treatments showed a highly significant difference ($p<0.01$) on physiological maturity (Table 3). The highest (96) and lowest (81) days required to physiological maturity were recorded on 92kgN/ha and control (0 kgN/ha) treatments, respectively. The lowest seed rate (75kg/ha) took longer period (88.7 days) to mature, while the highest seed rate (150kg/ha) exhibits shorter period of time (85.7days) to maturity (Table 3). As seed rate increased, plant population per unit area increased that contributed for competition for the available resources and hasten maturity time (Brady and Weil, 2002; Getachew, 2004).

Table 3. Nitrogen and seed rates effect on phenological parameters of wheat

N rate kg/ha	Days to 50% Emergence	Days to Heading	Days to 85% Physiological Maturity
0	6.8ba	48b	81.3d
23	7.72ba	50b	84.58c
46	7.5000ba	52.0b	85.17c
69	7.83ba	56.0a	90.45b
92	7.67ba	57a	96.08a
Seed rate kg/ha			
75	6.3c	57.80a	88.7a
100	7.2b	52.87b	88.47a
125	8.2a	49.47b	87.13ba
150	8.47a	49.3 b	85.7b
Mean	7.6	52.37	87.52
SE (+)	1.1	5.26	2.7
CV (%)	14.8	10.04	3.08

Means followed by the same letters are not significantly difference at p<0.05 according to DMRT.

Yield and Yield Components

Leaf area at flowering stage

Both main and interaction effect of N fertilizer and seed rates were found to significantly ($p<0.01$) affect leaf area of wheat crop (Table 4). The highest (14.39cm^2) and lowest (8.44cm^2) leaf area were obtained with 92kgN/ha and 75kg/ha seed rate, and control N and 150kg/ha seed rate, respectively (Table 4). Leaf area increased with increasing the application of N level and low seed rate, while leaf area decreased with increasing seed rate which shows the enhanced intra-plant competition. Many authors (Rafiq *et al*., 2010; Minale *et al*., 2006; Tahir *et al*., 2006) also reported that with increasing the levels of nitrogen, the yield component like leaf area of wheat increased.

Table 4. Interaction effect of N and seed rates on leaf area of wheat

Seed rate (kg/ha)	Applied N rate(kg/ha) 0	23	46	69	92	Mean
	Leaf area(cm^2)					
75	9.4f	11.4e	11.6ed	13.3a-d	14.39a	12
100	9.5f	12.3c-e	12.6a-e	13.6a-c	14.26ba	12.5
125	8.99f	12.8a-e	12.7a-e	12.57b-e	14.29ba	12.3
150	8.4fg	11.08e	11.8c-e	12.63a-e	13.6a-c	11.5
Mean	9.1	11.9	12.2	13	14.1	
SE (+)			0.909			
CV(%)			7.58			

Means followed by the same letters are not significantly different at p<0.05 according to DMRT.

Number of fertile tillers and total number of tillers per plant at maturity

Among the yield components, fertile tillers per plant are very important because the final yield is a function of the number of spike-bearing tillers per unit area. The N fertilizer rate significantly affects ($p < 0.01$) the number of fertile tillers per plant, with a decreasing trend of fertile tillers observed with increasing seed rate; however their interaction had no significant ($p<0.05$) effect on fertile tiller per plant (Table 5). The lowest (2.4) and highest (4.7) fertile tillers were recorded on the control N plots and 92kgN/ha treatments, respectively; while increased in seed rate from 75kg/ha to 150kg/ha, decreased fertile tillers from 3.8 to 3.6 per plant (Table, 5). This result is in agreement with Pandey and Sinha, (2006) who reported that productive tillers increased with the application of more N as compared to lower levels of N, and the application of N at booting stage increase the availability of N at later stages of crop growth which directly contributes to increase in yield of the crop. Similarly, Ejaz *et al.*, (2002) also reported that application of N at the rate of 92kg/ha produced higher number of productive tillers per unit area as compared to the control and low N treatments.

The application of N fertilizer moreover significantly affect ($p < 0.01$) the number of total tillers per plant, while the main effect of seed rate and interaction effect were not significant ($p < 0.05$) (Table 5). The highest (5.0) and lowest (2.9) total tillers at maturity were recorded from the application of 92kgN/ha and no fertilizer N (control), while the increasing of seed rate from 75 to 150kg/ha result decreasing of total tillers per plant from 4.1 to 3.9 in number, respectively (Table 5).

Plant height

The main effects of applied N fertilizer and seed rates were highly significant ($p<0.01$) on plant height (Table 5). However, no significant interaction between N fertilizer and seed rates on plant height. The highest (73.8cm) and lowest (54.0cm) plant heights were obtained from plots that received 92kgN/ha and control treatments, respectively (Table 5). There was linear increase in plant height with increase in rate of N from 0 to 92kgN/ha. On the other hand, when the seed rate was increased from 75kg/ha to 150kg/ha, the plant height slightly decreased from 65.9cm to 64cm. The findings of the study are similar to the results of previous works which showed significant increment in plant height as the N fertilizer application rate increases (Amanuel, 1990; El-Karamity, 1998).

Table 5. Main effect of nitrogen and seed rates on growth parameters of wheat

Nitrogen and seed rate(kg/ha)	Fertile Tillers per plant	Total Tillers per plant	Plant height(cm)
0	2.4e	2.9d	54.0e
23	3.4d	3.7c	62.6d
46	3.7c	3.9c	65.9c
69	4.3b	4.5b	69.6b
92	4.7a	5.0a	73.8a
Seed rate kg/ha			
75	3.76a	4.05a	65.8a
100	3.79a	4.07a	65.91a
125	3.71b	4.00b	64.85b
150	3.56c	3.85b	64.11c
Mean	3.71	4.0	65.2
SE (+)	0.39	0.38	3.6
CV (%)	10.6	9.5	5.6

Means followed by the same letters are not significantly different at p < 0.05 according to DMRT.

Stand count at maturity

The analysis of variance showed that both main and interaction effect of N fertilizer and seed rates significantly ($p<0.05$) affected plant stand count per 0.5m at maturity (Tables 6).With increasing level of N fertilizer and seeding rates, the stand count also increases. The highest stand count (80.0) per 0.5m length was recorded with the application of 92Nkg/ha and 125kg/ha seed rate followed by 92kgN/ha and 150kg/ha seed rate while the lowest stand count (41.00) per 0.5m length was recorded from the combination of control N and 75kg/ha seed rate (Tables 6).

Table 6. Interaction effect of N and seed rates on plant stand count at maturity

Seed rate	Applied N rate(kg/ha)					
(kg/ha)	0	23	46	69	92	Mean
	Stand count at maturity per 0.5m					
75	41.0f	65.47d	67.8d	65.6d	69.2bd	61.8
100	41.6f	67.07d	67.4d	69.5b-d	69.47bd	63
125	43.7ef	68.07dc	69.9b-d	67.9dc	79.47a	65.8
150	45.87e	68.87b-d	74.0a-c	70.4b-d	74.86ba	66.8
Mean	43.05	67.367	69.7668	68.3665	73.2485	
SE (+)			3.1			
CV (%)			4.8			

Means followed by the same letters are not significantly different at $p< 0.05$ according to DMRT.

Number of spikes per 0.5m length and spike length

Number of spikes per 0.5m row length and spike length responded significantly ($p<0.05$) to the main and interaction effect of N fertilizer and seed rates (Table 7).The number of spike per 0.5m increase with increasing N fertilizer and seed rates. The highest (73.45) and lowest (34.97) number of spikes were recorded from 92kgN/ha with 125kg/ha seed rate and control N with 75kg/ha seed rate, respectively (Table 7).The highest (8.3cm) and lowest (5.3cm) spike length were also recorded from the application of 92Nkg/ha and 75kg/ha, and 0 kg N/ha (control) with 150kg/ha seed rate, respectively (Table, 7).As seed rate increased the spike length decreased due to increasing intra-plant competition for resource and produced unfertile spikes. Spike length increased with increasing the level of applied N fertilizer due to the availability of nitrogen in sufficient quantity to keep the plant healthy which ultimately resulted in proportional increase in spike length corresponding to the amount of fertilizer used when compared to the unfertilized wheat crops (Ejaz *et al*., 2002). Similarly, Worku (2008) reported that high seeding rate generally increases number of spikes per square meter, however unfertile, fewer and smaller kernels per spike can occur which may results to change in total grain yield.

Number of kernels per spike and spikelets per spike

The analysis of variance result showed that number of kernel per spike was significantly ($p<0.05$) affected by the main effects of N fertilizer and seed rates (Table 8), while spikelets per spike was significantly affected by the interaction of N fertilizer and seed rate (Table 9). As N fertilizer increased from control to highest (92kgN/ha) the number of grains per spikes increased from 26 to 36.9, while increasing seed rate from 75 to 150kg/ha decreased kernel per spike from 33.6 to 30.5, respectively. The interaction effect of N and seed rates indicated that the highest (13.9) and lowest (7.1) spikelets per spike were obtained from the combination of 92Nkg/ha and control N with 75kg/ha and 150kg/ha seed rate, respectively (Table 9). In line with the results obtained from this study, Ayoub *et al*., (1994) reported that nitrogen increase the number of grains per spike which is the best indicator of wheat response to nitrogen. Moreover, Hussins and Pan (1993) reported that the number of kernels per spike decreased with an increased in seeding rate, while both kernels per spike and kernels weight was found to be inversely related to seeding rate because of intra-plant competition for resources including essential nutrients.

Table 7. Interaction effect of N and seed rates on number of spike per 0.5m row and spike length

Seed rate (kg/ha)	Applied N rate(kg/ha) 0	23	46	69	92	**Mean**	Applied N rate(kg/ha) 0	23	46	69	92	**Mean**
	Number of Spikes per 0.5m						Spike length(cm)					
75	34.97e	57.5c	58bc	64.79bc	64.66bc	56.1	5.8f-h	7.0c-e	7.5a-d	7.8a-c	8.3a	7.3
100	35.37d	63.0c	63bc	66.5ba	63.35bc	58.3	5.8hg	6.7d-f	7.5a-d	7.9a-c	8.1ba	7.2
125	35.9d	65.4a-c	62bc	63.95bc	73.452a	60.0	5.7hg	6.5e-g	7.1b-e	7.8a-c	7.8a-c	7.0
150	38.98d	61.6bc	67ba	67.1ba	67.3ba	60.4	5.3hg	6.4e-g	6.4e-g	7.5a-d	7.5a-d	6.6
Mean	36.3	61.96	62.39	65.6	67.19		5.7	6.7	7.1	7.7	7.9	
SE (+)				3.5					0.49			
CV (%)				6.0					7.05			

Means followed by the same letters are not significantly different at p< 0.05 according to DMRT.

Table 8. Main effect of nitrogen and seed rates on number of kernels per spike

N rate kg/ha	Number of Kernels
0	26.23c
23	30.57b
46	30.98b
69	35.17a
92	36.87a
Seed rate kg/ha	
75	33.6a
100	32.07ba
125	31.6b
150	30.5b
SE (+)	2.61
CV (%)	8.16

Means followed by the same letters are not significantly different at p< 0.05 according to DMRT.

Table 9. Interaction effect of N and seed rates on spikelets per spike

Seed rate (kg/ha)	Applied N rate(kg/ha) 0	23	46	69	92	Mean
	Spikelet per Spike					
75	7.7f	11.7a-d	13.2a-c	13.2a-c	13.9a	11.9
100	7.6f	12.2b-e	12.7a-d	12.8a-d	13.2a-c	11.7
125	7.2f	11.6c-e	11.7b-e	11.7b-e	13.3ba	11.1
150	7.1g	10.7e	11.3de	11.7b-e	11.8b-e	10.5
Mean	7.4	11.6	12.2	12.4	13.1	
SE(+)			0.78			
CV (%)			6.9			

Means followed by the same letters are not significantly different at p< 0.05 according to DMRT.

Lodging percentage

Wheat plants on each net plot were randomly observed with aim to count those which were found tilted from the normal up-right position by 45^0. The assessment was conducted by visual observation. However, any plots of the plants didn't show lodging and hence no data were recorded and reported.

Grain yield, Biological yield, Straw yield, Thousand grain weight and Harvest index

Grain yield

Grain yield of the bread wheat was significantly (p <0.01) affected by the interaction of N and seed rates. The lowest (1206.5 kg/ha) and the highest (3790.2 kg/ha) grain yields were obtained from the combination of control N and 75kg/ha seed rate, and 92 kg N /ha with 125kg/ha seed rate treatments, respectively (Table 10).The results obtained from this study is in line with that of Getachew, (2004) who observed a significant increase in grain yields of bread wheat crop with increasing levels of N fertilizer and seed rates. On the other hand, Hamid *et al*., (2002), and Khan *et al*., (2002) also reported that maximum grain yield was obtained with increase in seed rate, while minimum grain yield was produced by low seed rate.

Table 10. Interaction effect of N and seed rates on grain yield of wheat

Seed rate (kg/ha)	Applied N rate(kg/ha) 0	23	46	69	92	Mean
		Grain yield (kg/ha)				
75	1206.5g	2217.5e	2214.7e	2938.7b-e	3048.8bc	2275.9
100	1266.4f	2573.8c-e	2795.5b-e	2969.3b-d	3242.1ba	2563.3
125	1553.0f	2590.6c-e	2798.6b-e	3103.7bc	3790.2a	2740.3
150	1507.9f	2378.9ed	2802.1b-e	3153.9bc	3058.0bc	2640.5
Mean	1356.0	2440.2	2728.13	2966	3284.78	
SE (+)			11.57			
CV (%)			11.96			

Means followed by the same letters are not significantly different at p< 0.05 according to DMRT.

Thousand grain weight

Thousand grain weights is an important yield determining component which is reported to be a genetic characteristic of a plant. The analysis of variance indicated that both main and interaction effects of applied N fertilizer and seed rates showed highly significant difference on thousand grain weight (Table 11).

Table 11. Interaction effect of N and seed rates on 1000-grain weights

Seed rate (kg/ha)	Applied N rate(kg/ha)				
	0	**23**	**46**	**69**	**92**	**Mean**
	Thousand grain weight(g)					
75	25.3h	31.0f	32.3d-f	32.7c-f	36.3bc	31.5
100	26.3g	32.0fe	34.0c-f	36.0b-d	39.3ba	33.5
125	27.0g	33.7c-f	35.7b-e	36.3bc	42.7a	35.1
150	25.7g	33.3c-f	34.0c-f	35.3c-e	40.3a	33.7
Mean	26.1	32.5	34.0	35.1	39.7	
SE(+)			1.44			
CV (%)			4.31			

Means followed by the same letters are not significantly different at p< 0.05 according to DMRT.

The thousand grain weight increased with increasing levels of applied N fertilizer. The highest (42.7g) and lowest (25.3g) grain weight was obtained with 92kgN/ha and 125kg/ha seed rate, and control N and 75kg/ha seed rates, respectively (Table 11). Similar finding had been reported by Husain and Shah, (2002); and Iqtidar *et al*., (2006).

Biological yield

Total biological yield was significantly ($p < 0.05$) affected by main and interaction effect of both N and seed rates (Table 12).The highest (12384.3kg/ha) total biological yields was recorded from 92kgN/ha and 125kg/ha seed rate plots, while the lowest (6018.5kg/ha) was obtained from the zero N with 75kg/ha seed rate respectively (Table 12). Results obtained from this study agrees with the findings of Ejaz *et al.,* (2002) who reported that as N rate increased the biological yield also increased. Mengel and Krikby (1996) reported that biological yield generally increased up to maximum point for moderate population densities followed by significant reduction in total biological yield at high population densities.

Table 12. Interaction effect of N and seed rates on biological yield

Seed rate (kg/ha)	Applied N rate(kg/ha)					
	0	**23**	**46**	**69**	**92**	**Mean**
	Biological Yield (kg/ha)					
75	6018.5h	8449.1f	8333.3f	9606.5ed	10300.9c-d	8542
100	6250.0hg	9143.5fe	8912.0fe	10300.9c-d	11342.6b	9190
125	6828.7hg	9838.0c-e	10416.7c-d	10416.7c-d	12384.3a	9977
150	7175.9g	8333.3f	10416.7c-d	10995.4b	10879.6cb	9560
Mean	6568.3	8940.98	9519.68	10329.9	11226.85	
SE(+)			1072.9			
CV (%)			12.39			

Means followed by the same letters are not significantly different at p< 0.05 according to DMRT.

Straw yield and Harvest index

The interaction effect of N fertilizer and seed rates significantly ($p < 0.05$) affected straw yield and harvest index of bread wheat (Table 13). The highest straw yield of 7783.9kg/ha was obtained with the application of 92N kg/ha and 125kg/ha seed rates whereas, the lowest straw yield (3594.7 kg/ha) was obtained with zero N (control) and a seed rate of 75kg/ha. Similarly, Sabir *et al.*, (2002) reported that with increasing applied N rates, straw yield also increased, while as seeding rate increased, there was a corresponding increase in straw straw yield due to higher stand number at crop establishment period. The highest (34.2%) and lowest (23.4%) harvest index was obtained from the combination of 69kgN/ha with 100kg/ha seed rate, and control N treatment with 75kg/ha seed rate (Table 13).

Table 13. Interaction effect of N and seed rates straw yield and harvest index

Seed rate	Applied N rate(kg/ha)						Applied N rate(kg/ha)					
(kg/ha)	0	23	46	69	92	Mean	0	23	46	69	92	Mean
	Straw yield(kg/ha)						Harvest index(kg/ha)					
75	3594.7i	4958.4f-h	5308.4d-g	5994.2b-e	6441.9b-d	5260	23.4c	29.5ba	32.98ba	28.4a-c	27.3a-c	28.32
100	3880.3ih	5759.5c-f	5190.6e-g	6204.9b-e	7058.8ba	5619	27.6a-c	26.2bc	29.3a-c	34.2a	31.2ba	29.7
125	3886.8ih	6089.9c-f	6692.1a-c	6174.2b-e	7783.9a	6125	30.9ba	31.72ba	26.0bc	32.5ba	31.9ba	30.6
150	4742.1gh	5491.4c-f	6155.6b-e	6684.0a-c	7011.5ba	6017	27.6a-c	31.6ba	32.8ba	32.4ba	30.0ba	30.9
Mean	4026	5574.8	5836.7	6684	7074.03		27.4	29.8	30.27	31.9	30.1	
SE(+)						477.5						
CV (%)						8.3						

Means followed by the same letters are not significantly different at $p < 0.05$ according to DMRT.

Conclusion and Recommendation

The study showed that, wheat yields increased with increasing rates of both N fertilizer from 0 to 92kg N/ha and seed rate from 75kg/ha to 150kg/ha respectively. The results confirmed that nitrogen and seed rates influenced phenological, growth, yield and yield components of bread wheat. Based on the results, the combination of 92kg/ha N fertilizer and 125kg/ha seed rates was found to improve growth and provide higher yield of bread wheat under irrigated lowland area. Hence, it is suggested.

In addition, from the observations and output of this study; for increasing production of wheat in lowland areas, developing of salt tolerant wheat variety and studying N and seed rate interaction with their appropriate integrated agronomic practices is recommended for the future. Considering the area and water availability in the Awash rift valley areas, irrigated wheat production using appropriate technologies should be promoted for food self- sufficiency in the country.

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