International Journal of Agricultural and Life Sciences

ISSN: 2454-6127(Online) Journal homepage: http://www.skyfox.co

Response of Nitrogen Fertilizer and Seed Rates on Growth, Yield and Yield Components of Irrigated Bread Wheat in the lowlands of Eastern and South Eastern of Oromia, Ethiopia

Alemayehu Biri*[1], Fikadu Tadesse[2], Girma Mengistu[3], Tamiru Meleta[4], Mengistu Bogale[4], Urgaya Balcha[5] and Temesgen Dinsa[5]

To cite this article : Biri, A., Tadesse, F., Mengistu, G., Meleta, T., Bogale, M., Balcha, U., & Dinsa, T. (2023). Response of Nitrogen Fertilizer and Seed Rates on Growth, Yield and Yield Components of Irrigated Bread Wheat in the lowlands of Eastern and South Eastern of Oromia, Ethiopia. Int J Agric Life Sci, 9(3), 403-413. doi: 10.22573/spg.ijals.023.s122000115

To link to this article : https://doi.org/10.22573/spg.ijals.023.s122000115

Data Availability Statement : All relevant data are within the paper and its Supporting Information files.

Funding : The author(s) received no specific funding for this work.

Competing Interests : The authors have declared that no competing interests exist.

International Journal of Agricultural and Life Sciences- IJALS (2023), Volume 9 (3) pp.403-413
http://dx.doi.org/10.22573/spg.ijals.023.s122000115
Available online at http://www.skyfox.co
ISSN: 2454-6127

RESEARCH ARTICLE

Response of Nitrogen Fertilizer and Seed Rates on Growth, Yield and Yield Components of Irrigated Bread Wheat in the lowlands of Eastern and South Eastern of Oromia, Ethiopia

Alemayehu Biri*[1], Fikadu Tadesse[2], Girma Mengistu[3], Tamiru Meleta[4], Mengistu Bogale[4], Urgaya Balcha[5] and Temesgen Dinsa[5]

[1*]Fitche Agricultural Research Center P.O. Box, 109, Fitche, Ethiopia
[2]Fadis Agricultural Research Center P.O. Box, 904 Harar, Ethiopia
[3]Oromia Agricultural Research Institute, P.O. Box 81265, Addis Ababa, Ethiopia
[4]Sinana Agricultural Research Center, P.O. Box 208, Bale Robe, Ethiopia
[5]Adami Tulu Agricultural Research Center, P. O. Box 35, Batu, Ethiopia
*Author to whom correspondence should be addressed; E-Mail: alex2hny@gmail.com

Received: 26 Jun 2023/ Revised: 21 July 2023/ Accepted: 22 Aug 2023/ Published: 30 Sep 2023

Abstract: The main factors responsible for low yield are less or more plant population and inadequate crop nutrition. As the plant density increases, the competition for resources especially for nitrogen also increases that badly affects the ultimate yield. Therefore, a field experiment was conducted at five multi-location of lowlands of Oromia in three zones, Bale (Dalomena and Sawena), East Shewa (AdamiTulu and Lume), and East Hararghe (Bedeno) districts in 2020/2021 off-season to investigate the response of nitrogen and seeding rates on the growth, yield and yield components of bread wheat variety under irrigation. The treatments consisted of five rates of nitrogen 0, 23, 46, 69, 92 kg ha-1 and three seed rates (125, 150 and 175 kg/ha) of Kakaba variety. The experiment was laid out as a randomized complete block design in a factorial arrangement and replicated three times. The analysis of variance revealed significant differences in the parameters studied. The results of this study revealed that the soil was improved in little beat in PH, organic carbon, total nitrogen and available phosphorus. The combined effects of nitrogen and seed rates significantly influenced the irrigated bread wheat growth parameters. However, nitrogen had more profound effects in enhancing the growth response of the crop than seeding rates. The combined mean effect of the nitrogen and seed rates was significantly ($P < 0.05$) influenced days to heading, days to maturity, plant height, spike length, seed per spike, biological yield, grain yield and harvest index, whereas, significantly not influenced total tiller per plant, effective tiller per plant and thousand grain weight. The results showed that the maximum grain yield and harvest index were recorded at a seeding rate of 150 kg ha-1 with nitrogen rates of 92 N ha-1 and also at 125 kg ha-1 and 69kg N ha-1. Biological yield recorded at a seeding rate of 175 kg/ha with nitrogen rates of 69 kg N ha-1. The economic analysis also revealed that for a treatment to be considered worthwhile to farmers (100% marginal rate of return), application of 69 kg N ha-1 with 125 kg seed rate N are profitable and recommended for farmers in the study area and similar agro-ecologies.

Keywords: Irrigation, nitrogen, seed rate, yield components, wheat.

INTRODUCTION

Agriculture sector is the important component of the country's economy and continues to be the single largest sector that is acting as a dominant driving for growth and development of the national economy (AGRA, 2018). Agriculture is also the backbone of the Ethiopian economy, and more than 85% of the national growth domestic product of the country is derived from the agricultural sector. Its economy was registered 7.7% growth in 2017/2018, slower than the 10.9% expansion recorded in 2015/2016. This growth was attributed to 12.2% rise in industrial output, 8.8% expansion in the service sector and 3.5% growth in agriculture (NBE, 2018). Crop production is a major contributor to GDP, accounting for approximately 28% of the sub-sectors of agriculture. According to Ejersa (2011), coffee, pulses, oilseeds, potatoes, sugarcane, vegetables and cereals are the principal crops grown in Ethiopia. Among the above-listed types of crops, cereals are the most important food crop which provides daily food calories to the people. But in another production year of 2014/2015, the total grain production reached 270.4 million quintals, of which cereal production accounted for 235.45 million quintals (CSA, 2015). The total grain crops produced during the year 2015/2016 increased by 2.41% from the 2014/2015 total production (CSA, 2016). On the other hand, the report of CSA (2018, 2019) indicates that the total cereal production of wheat was 267.8 million quintals and 277.7 million quintals in 2017/2018 and 2018/2019 production seasons, respectively. Based on the report, there is a 3.67% change in production between the two production seasons. Wheat is one of the globally produced and marketed cereal crops which covers 15% of the total sowing areas of cereal crops in the world (Kiss, 2011). It is an important industrial and food grain which ranks second among the most important cereal crops in the world after rice and is traded internationally (Asadallah, 2014; Falola *et al.*, 2017).

In sub-Saharan African countries, wheat is also a strategic commodity that generates farm income and improves food security status (Amentae *et al.,*2017; Minot *et al*., 2015; Negassa *et al*., 2013). Many African countries are producing wheat for both consumption and sale, but the level of production and sale is varied between countries. Ethiopia is one of the largest wheat producers in terms of total wheat area cultivated and total production (CSA, 2012). Wheat and wheat products represent 14% of the total calorie intake in the country which makes wheat the second-most important food behind maize (19%) and ahead of tef (10%), sorghum (11%), and *enset* (12%) (FAO, 2014). In Ethiopia, wheat ranks fourth after tef, maize and sorghum in area coverage and third after maize and tef in total production (CSA, 2012; Minot *et al.,*2015). But, the production of wheat is tremendous of a subsistence nature and dominated by the country's numerous smallholder farmers that cultivate more of wheat for consumption and less of it for the market (Matouš *et al*., 2013). Wheat is one of the strategic crops in Ethiopia, because of its role in food security, import substitution and supply of raw material for the agro-processing industry. Wheat is one of the major cereal crops produced by 4.6 million smallholder farmers on 1.8 million hectares of land with an estimated annual production of 5.0 million tons at an average productivity of 2.8 t/ha which has been consistently increasing for the last 25 years, but much lower than the world average 3.3 t/ha. Despite the recent production increment, Ethiopia falls short of being self-sufficient in wheat production and continually remains a net importer of about 1.7 million tons of wheat severity of the problems predominate the frequently water-logged soils of high land vertisols and only producing in the main season(Tekalign *et al*., 1988; Syers *et al*., 2001). Unlike the rain-fed agro-ecologies, off-season irrigated wheat is constrained mainly by inadequate number of wheat varieties and a lack of knowledge in wheat irrigation technologies.

However, the irrigated wheat production technologies are not yet well introduced in Oromia. There is significant potential to further increase irrigated wheat production in Oromia with optimal agronomic management. Research in dryland cropping systems has proven the positive impact of tailoring agronomic management to specific-varieties and geographical locations has on grain yield and grain quality. However, dryland varietal recommendations and variety specific agronomic packages are not necessarily valid in irrigated cropping systems thus there is a requirement for further research in irrigated farming systems. Irrigated wheat production systems have evolved over recent years with the identification of agronomic management practices tailored to varieties (Lacy & Giblin, 2006). Irrigated wheat yields are primarily determined by how well the crop's requirements for growth are met and yield-reducing factors such as poor plant nutrition and seed rate are minimized. Crop inputs and management that can affect grain yield, grain quality and lodging include varietal selection, plant population, sowing date, irrigation frequency, grazing management, fungicide application, plant growth regulators, nitrogen rate and timing of nitrogen application (Lacy & Giblin 2006).

However, irrigated wheat growers in Oromia commonly yield less than the potential yield and continued research is required to fine-tune crop management recommendations to assist growers to achieve a higher target yield. The main factors responsible for low yield are less or more plant population and inadequate crop nutrition. Plant density is a major factor determining the ability of the crop to capture resources and generate yield. It can be developed by using a suitable seeding rate. Growth and yield of wheat are affected by environmental conditions and can be regulated by sowing time and seeding rate (Ozturk *et al*., 2005). As the plant density increases, the competition for resources especially for nitrogen also increases that badly affects the ultimate yield. Numerous studies have documented how N fertilization (Campillo *et al*., 2010; Hirzel *et al*., 2010; Zecevic *et al.,* 2010; Nikolic *et al.,* 2012), seeding rate, planting date, row spacing, and seeding depth affect yield and yield components of wheat (Kristó *et al.,* 2007; Maric *et al*., 2008; Otteson *et al.,* 2008; Valério *et al.,* 2009). Therefore, the provision of additional nitrogen can be hypothesized to further enhance the yield by increasing plant population but up to an optimum level. Further, higher nitrogen can lead to the lodging of plants at a higher seed rate (Nazir *et al.,* 2000). Nitrogen occupies a conspicuous place in plant metabolism.

All vital processes in plant are associated with protein, of which nitrogen is an essential constituent. Proper use of nitrogen is also considered for farm profitability and environmental protection (Makowski *et al.,* 1999). Reports indicated that appropriate level of nitrogen application has increased wheat yield significantly (Gwal *et al*., 1999; Ali *et al.,* 2000). Among all the essential nutrients applied in the field, nitrogen is the most important for vegetative crop growth, plant productivity and grain quality (Frink *et al.,* 1999). As appropriate nitrogen level and seeding rate are very limiting factors, the current research was conducted to determine appropriate nitrogen levels and seeding rates for optimum grain yield of wheat under irrigation in lowlands of Oromia. Therefore, the main objective of the study was to investigate the optimum nitrogen and seed rates for better growth, yield and yield components of irrigated wheat in lowland areas of Oromia

MATERIALS AND METHODS

Description of the study area

The experiment was conducted in five locations of Oromia Regional state in three zones, Bale (Dalomena and Sawena districts), East Shewa (AdamiTulu and Lume districts) and East Hararghe (Bedeno district) in 2020/2021 off-season to investigate the response of nitrogen and seeding rates on the growth, yield and yield components of bread wheat variety under irrigation. The locations, altitudes, climate and major crops grown in the study area are described below table.

Table 1. Agro-ecology profile of the study area

Districts	Altitude	Rainfall	Temperature	Major crops
Adami Tulu	1650m	760.9m	12.6 &27^{0}C	Maize, Haricot Bean , Onion, Tomato
Lume	1608m	896.3m	11^{0}C & 33^{0}C	Tomato, onion, maize
Bedeno	1450m	600m	16^{0}C& 30^{0}C	Sorghum, maize, khat, coffee, sweet potato
Dalo Mena	1350m	700m	21^{0}C & 38^{0}C	Maize, Sesame, Coffee, avocado, mango
Sawena	1125m	600m	-	Vegetables

Description of the Experimental Materials

Bread wheat variety "Kakaba" was used as a test crop. The variety has been released by kulumsa Agricultural Research Center in 2010. It is an early maturing cultivar which is suited at an altitude ranging from 1500-2200m with a rainfall amount ranges from 500-800 mm. It requires 90-120 days to mature with a yield potential of 3300-5200 kg/ha under experimental field and 2500-4700 kg/ha at farmer's management. Phosphate fertilizer in the form of NPS was applied at sowing at a rate of 100 kg h^{-1}a NPS (19% N, 38% P_2O_5 and 7% S) which was uniformly applied to all experimental plots except zero plot and different rates of Urea (46% N) as a source of nitrogen with different types of seed rates were used.

Treatments and experimental design

The treatments consisted of five N rates 0, 23, 46, 69, 92 kg ha^{-1} N and three seed rates (125, 150 and 175 kg ha^{-1}) were used. The experiment was laid out as a Randomized Complete Block Design (RCBD) in a factorial arrangement and replicated three times per treatment. Plants were spaced at 0.5, 1 and 2 m between ridge rows, plots and blocks, respectively (MoARD, 2010). The gross experimental area was 39m x 31m and net area of 37m × 29m in a plot size of (3m × 5m = 15 m^2) with ridge to ridge distance of 50 cm having six ridges rows. The experimental field was ploughed and harrowed by a tractor and oxen to bring the soil to fine tilth. The plots were laid out as per plan and levelled by oxen. An irrigation channel of 1 m wide was laid in between the replications to irrigation of individual plots independently and equally until the crop grew up to the maturity stage. Nitrogen was applied to the plants in splits, 1/3 at sowing and 2/3 at tillering. All the experimental plots were irrigated uniformly commencing at planting in 8-10 days interval and all the crop protection mechanisms were applied until the wheat crop reaches physiological maturity.

Soil Sampling and Analysis

Initial representative soil samples were collected from a depth of 0-30 cm from the entire plot in a zigzag pattern according to standard method. The sample was air dried, ground, sieved through a 2 mm sieve and used for the analysis of soil. Soil samples after harvest of the crops were collected from a depth of 0-30 cm from all plots except the control and the physico- chemical properties of the prepared samples were analyzed at Bedele research center of soil test laboratory. Soil texture was determined by the Bouyoucons Hydrometer method and the soil pH was determined in 1:2.5, soil water suspension by glass electrode using a digital pH meter (Piper, 1966). Estimation of organic carbon in soil was determined by Walkley and Black method (1934) and expressed in percentage. The total nitrogen content of soil samples was determined by the Modified Kjeldahl method and expressed in percentage (Jackson, 1962). Available phosphorus content of soil samples was estimated by Olsen's method (Jackson, 1967) and expressed in ppm. Exchangeable potassium was estimated by a flame photometer from the extract of neutral normal ammonium acetate (Jackson, 1967) and expressed in cmol (+)/kg soil.

METHODS OF DATA COLLECTION

Phenological and growth parameters

Days to heading (DH): The number of days from sowing up to a date when 50% of the plants in a plot had produced spikes was recorded in plot basis.

Days to maturity (DM): The number of days from sowing to physiological maturity of the plants became 85% mature in each plot and the crop stands; stems, leaves and floral bracts changed to light yellow color was recorded on plot basis

Plant Height (cm): Plant height was measured from the soil surface to the tip of a spike (awns excluded) randomly taken 5 plants each from plot area at physiological maturity.

Number of total tillers per plant (TT): The total tiller populations were recorded from five randomly taken samples using 1m^2 quadrants in each plot and converted to plot basis before the time of heading.

Number of productive tillers per plant (ET): The total Effective tiller populations were recorded from five randomly taken samples using 1m^2 quadrants in each plot and converted to plot basis after heading.

Spike length (SL): The main spikes from twenty sampled plants of each plot were measured in cm and averaged to represent the spike length in cm.

Yield and yield components

Number of Seed per Spike: The mean number of kernels per spike was recorded as an average of 5 randomly taken spikes from the net plot area.

Thousand Kernel Weight: Thousand kernels weight was determined based on the weight of 1000 kernels sampled from the grain yield of each net plot by counting using an electronic seed counter and weighed with electronic sensitive balance. Then the weight was adjusted to 12.5% moisture content.

Aboveground Dry Biomass Yield: The aboveground dry biomass yield was determined from plants harvested from the net plot area after sun drying to a constant weight and expressed in t ha^{-1}.

Grain Yield: The grain yield was taken by harvesting and threshing from net plot area. The yield was adjusted to 12.5% moisture content and expressed as yield in t ha^{-1}**.**

Harvest Index (HI): The harvest index was calculated as a ratio of grain yield per plot to total above ground dry biomass yield per plot expressed as a percent**.**

Statistical Data Analysis

The collected data were subjected to the analysis of variance (ANOVA) as per the experimental design using R software. The Least Significance Difference (LSD) at 5% level of probability was used to determine differences between treatment means. The economic analysis was carried out by using the methodology described in CIMMYT (1988) in which prevailing market prices for inputs at planting and for outputs at harvesting were used. All costs and benefits were calculated on hectare basis in ETB Birr.

RESULTS AND DISCUSSION

Soil Physico-Chemical Properties of the experimental site before Sowing

The physico-chemical properties of the experimental soil are shown in Table 2. The textural class of the experimental site is sandy loam, loam and sandy clay loam at Adami Tulu, Lume and Bedeno, respectively. Thus, the textural class of the experimental soil is ideal for wheat production (Onwueme and Sinha, 1991). According to the rating of Tekalign Tadesse (1991) the soil reaction (pH) is moderately alkaline at all locations which range 7.63-7.96, but it is within the optimum range for wheat production at all locations. FAO reported that the preferable pH ranges for most crops and productive soils are 4 to 8. Thus, the pH of the experimentalsoil is almost within the range for productive soils for irrigated wheat production. Organic matter of the soil was low according to the rating of Tekalign Tadesse (1991), Emerson (1991), and Charman and Roper (2007) at all locations except at Bedeno medium/moderate. Hence, amending the soils with organic fertilizers is important for enhancing soil fertility to increase crop yields.

According to Cottenie (1980), available P content below 5 mg/kg is very low; between 5 and 9 mg/kg is low; between 10 and 17 mg/kg is medium; between 18 and 25 mg/kg is high and greater than 25 mg/kg is very high. Therefore, the available P content of the experimental site was very low at all location except at Lume low and at Adami Tulu was medium. According to the rating of Tekalign Tadesse (1991), the total N content of the soil was very low at Delo Mena and low at Bedeno, which would limit wheat production. Therefore, the soils need amendment with nitrogen and/or organic fertilizers. With regards to the exchangeable potassium, Berhanu (1980) described soils, <0.26, 0.26 - 0.51, 0.51 - 0.77 and > 0.77 as very low, low, medium, and high, respectively. Thus, the exchangeable K of the experimental soil is very high at Adami Tulu and Lume. According to FAO (2006), exchangeable Ca content was very high at all locations, whereas, exchangeable Mg and Na contents were high at Lume and medium at Adami Tulu. CEC of the soil was medium at Adami Tulu, high at Lume and very at Bedeno according to the rating of Berhanu (1980). Although it will produce best on deep, fertile, well-drained loamy soils, it is much more tolerant of shallow soil and it can be grown successfully on clay, clay loam, or sandy loam soils (Mandefro *et al,* .2009). Therefore, the soil of the experimental site is ideal for irrigated wheat production except its limitation in the availability of phosphorus, total nitrogen, and organic carbon.

Soil Physico-Chemical Properties of the experimental site after harvest

The mean values of physicochemical properties of soil, after harvesting, shows particle size distribution of the surface layers of the experimental field was dominated by sandy(58.3%), clay fraction (8.7%), 33% silt at Adami Tulu and sandy (29.9%), clay fraction (26.3%), 48.3% silt at Lume and categorized as sandy loam and silt loam, respectively. The proportion of soil particle size after harvesting wheat differs from before sowing, sandy particle increased from 29.5 to 58.3%, while clay soil and silt fraction of the soil decreased at Adami Tulu ,whereas, in all soil particle size decreased in small amounts at Lume (Table 3). The average soil pH after harvesting was 7.7 and 7.9 at Adami Tulu and Lume, respectively, indicated that moderately basic reaction, which is within the range for productive soils (Charman and Roper, 2007). The average organic matter content of the soil after harvest was 0.18, 0.19, 1.5, and 2.2 at Adami Tulu, Lume Dalo Mena and Sawena, respectively (Table 3). The average total nitrogen percentage of the soil after harvest was 0.07, 0.1 at Dalo Mena and Sawena, respectively (Table 3). The results indicated that the nitrogen and organic matter contents were improved numerically and described asmedium accordingly. The available phosphorus content of the experimentalarea after harvest was 14.3, 8.8, 2.5, 3.3 ppm at Adami Tulu, Lume, Dalo Mena and Sawena, respectively, which indicates an improvement to medium level at Adami Tulu and Lume and improved numerically but at low level at Delo Mena and Sawena.

Phenological and growth parameters

Days to heading

The analysis of variance revealed that the main effects of nitrogen and seed rates significantly ($P < 0.01$) influenced days to 50% heading of irrigated wheat. Similarly, the combined mean effects of nitrogen and seed rates significantly ($P < 0.05$) influenced days to 50% heading of irrigated wheat across all locations (Table 4). Thus, increasing the rate of nitrogen prolonged the days required for 50% heading across all the increased rates of seed. As indicated in table 4, the most prolonged duration (60 days) to reach 50% heading was observed in response to the combined mean 46 kg N ha^{-1} + 175 kg ha^{-1} seed rate. However, the minimum duration of 50% heading was observed in the control treatments (Table 4). Thus, plants grown in the treatment that received the higher combined rates of the seed with medium level of nitrogen had delayed heading by about 5% in days compared to plants grown at nill rates of the nitrogen fertilizer. This may be attributed to the effects of the N fertilizer in promoting cell growth and prolonging vegetative growth. The earlier days to 50% heading with a higher seeding rate (150 and 175 kg ha^{-1}) with nil N fertilizer might be due to higher competition for resources like nutrient, water, light and others, this helps plants to escape final stress (Table 4). The present result was in agreement with the research result of Manna *et al.* (2005) who reported that application of N fertilizer promoted vegetative growth, leading to prolonged days to heading. Similar to the present results, Mulatu and Grando (2011) reported that day to 50% heading was significantly delayed by higher seeding and nitrogen rates compared to the highest seed rate with by increasing N levels from nil on production of food barley.

Days to maturity

The analysis of variance showed that the main effects of nitrogen and seed rates significantly ($P < 0.05$) influenced days to 90% physiological maturity of irrigated wheat. Similarly, the combined effect of nitrogen and seed rates significantly ($P < 0.05$) affected days to 90% physiological maturity of irrigated wheat across all locations (Table 4). The results showed that wheat plants that received 46 kg N ha^{-1} + 175 kg ha^{-1} seed rate and 92kg N ha^{-1} + 175 kg ha^{-1} seed rate required 3% more duration to reach 90% physiological maturity than irrigated wheat plants grown in the control plots, respectively (Table 4). However, the control treatment with seed rates led the irrigated wheat plants to the earlier attainment of 90% physiological maturity as compared to 46 and 92 kg ha N^{-1} with a 175 kg ha^{-1} seed rate. The prolonged period required by the plants to reach maturity at higher rate of nitrogen might be attributed to the increase in leaf area duration, increased vegetative growth and increased light use efficiency. Nevertheless, the results obtained from the experiment indicated that increasing the rate of nitrogen fertilizer from nil to the highest level prolonged the days of maturity of the irrigated wheat plants linearly and significantly (Table 4). Increasing seeding rate by increasing N rate increased days to 90% physiological maturity from 101 days to 105 days. This may be due to the increased plant population and N fertilizers that increased intra-plant competition for nutrients and light, which prolonged the vegetative stage.This, might be attributed to the role nitrogen plays in promoting vegetative growth. This may have also contributed to the reduction in grain filling period, because at higher seed and N rates, heading and maturity were not hastened as compared to lower seed and N rates (Alemayehu, 2015). The result is supported by the findings of Frederick and Camberato (1995) and Deldon (2001) who reported that higher N levels resulted in delayed leaf senescence, sustained leaf photosynthesis and extended days to maturity. Gobeze (1999) similarly found that higher N rates delayed maturity in wheat. This is more or less in line with the findings of Gupta and Sharma (2000) that nitrogen promotes vegetative and lush growth thereby delaying plant maturity.

Table 2: Soil laboratory analysis result for irrigated wheat experiment site before planting

Site	Ph.H^{2}0	%	ppm	Mcq/l00g soil	Cmol(+)/Kg soil				%	Texture (%)			
	pH	TN	Av.p	CEC	Na	K	Ca	Mg	OM	Sand	Silt	Clay	Class
Adami Tulu	7.78	-	13.56	19.39	1.95	2.30	13.6	0.85	0.2484	29.5	61	9.5	Sandy loam
Lume	7.96	-	8.93	37.63	7.31	2.10	22.1	5.1	0.1656	30	44.5	25.5	Loam
Delo Mena	7.36	0.034	2.402	-	-	-	-	-	0.687	-	-	-	-
Sawena	7.63	0.075	1.873	-	-	-	-	-	1.494	-	-	-	-
Bedeno	7.62	0.08	1.4	51.28	-	-	74.5	0	3.85	52	20	28	Sandy clay loam

Table 3: Soil laboratory analysis result for irrigated wheat experiment site after harvest

Site	Treatments	Ph.H$_2$0	%	Ppm	Mcq/l00g soil	Cmol(+)/Kg soil				%	Texture (%)			
		pH	TN	Av.p	CEC	Na	K	Ca	Mg	OM	Sand	Silt	Clay	Class
Adami Tulu	0Kg N ha^{-1} with d/t Seed rates(125,150,175)	7.48	--	14.62	18.43	2.06	2.30	10.2	1.7	0.17	61.5	31	7.5	Sandy loam
	23Kg N ha^{-1} with d/t Seed rates(125,150,175)	7.64	--	14.17	18.82	2.00	2.32	10.2	3.4	0.17	59.5	33	7.5	Sandy loam
	46Kg N ha^{-1} with d/t Seedrates(125,150,175)	7.75	--	14.23	17.28	2.02	2.34	10.2	2.55	0.22	57.5	33	9.5	Sandy loam
	69Kg N ha^{-1} with d/t Seed rates(125,150,175)	7.76	--	14.75	18.24	2.00	2.36	11.9	1.7	0.19	55.5	35	9.5	Sandy loam
	92Kg N ha^{-1} with d/t Seed rates(125,150,175)	7.74	--	13.56	18.62	1.97	2.32	11.9	3.4	0.14	57.5	33	9.5	Sandy loam
	Mean	**7.674**	**--**	**14.266**	**18.278**	**2.01**	**2.328**	**10.88**	**2.55**	**0.178**	**58.3**	**33**	**8.7**	**Sandy loam**
Lume	0Kg N ha^{-1} with d/t Seed rates(125,150,175)	7.98	--	12.22	34.56	7.90	2.19	20.4	3.4	0.19	25.5	53	21.5	Silt loam
	23Kg N ha^{-1} with d/t Seed rates(125,150,175)	8.22	--	8.16	39.94	8.48	2.21	25.5	3.4	0.19	31.5	31	37.5	Clay loam
	46Kg N ha^{-1} with d/t Seed rates(125,150,175)	7.88	--	9.18	35.71	5.19	1.97	20.4	6.8	0.19	31.5	49	19.5	Loam
	69Kg N ha^{-1} with d/t Seed rates(125,150,175)	7.85	--	7.14	38.02	5.34	1.95	28.5	1,7	0.17	31.5	39	29.5	Clay loam
	92Kg N ha^{-1} with d/t Seed rates(125,150,175)	7.99	--	7.23	34.37	6.64	2.07	23.8	1.7	0.19	29.5	47	23.5	Loam
	Mean	**7.984**	**--**	**8.786**	**36.52**	**6.71**	**2.078**	**23.72**	**3.4**	**0.186**	**29.9**	**43.8**	**26.3**	**Silt loam**
Delo Mena	0Kg N ha^{-1} with d/t Seed rates(125,150,175)	7.39	0.069	1.66						1.38				
	23Kg N ha^{-1} with d/t Seed rates(125,150,175)	7.27	0.073	1.92						1.48				
	46Kg N ha^{-1} with d/t Seed rates(125,150,175)	7.26	0.068	4.14						1.37				
	69Kg N ha^{-1} with d/t Seed rates(125,150,175)	6.94	0.083	3.00						1.67				
	92Kg N ha^{-1} with d/t Seed rates(125,150,175)	7.24	0.076	1.98						1.52				
	Mean	**7.22**	**0.0738**	**2.54**	**0**	**0**	**0**	**0**	**0**	**1.484**	**0**	**0**	**0**	**0**
Sawena	0Kg N ha^{-1} with d/t Seed rates(125,150,175)	7.13	0.073	2.19						2.19				
	23Kg N ha^{-1} with d/t Seed rates(125,150,175)	6.87	0.110	2.84						2.20				
	46Kg N ha^{-1} with d/t Seed rates(125,150,175)	7.10	0.110	3.84						2.15				
	69Kg N ha^{-1} with d/t Seed rates(125,150,175)	7.02	0.110	2.85						2.28				
	92Kg N ha^{-1} with d/t Seed rates(125,150,175)	6.91	0.110	4.80						2.22				
	Mean	**7.006**	**0.1026**	**3.304**	**0**	**0**	**0**	**0**	**0**	**2.208**	**0**	**0**	**0**	**0**

Key words: Om= Organic matter, EC= Electro conductivity, Exch. Na, Ca, Mg & K= Exchangeable sodium, calcium, magnesium and Potassium, Av.p = Available Phosphorus, CEC= Cation Exchangeable Capacity, TN= Total nitrogen

Plant height

The result revealed that the main effect of nitrogen and seed rate significantly ($P < 0.05$) did not influenced plant height. However, the combined mean effect of the two factors significantly ($P < 0.01$) influenced irrigated wheat plant height across all locations (Table 4). The tallest plants (73.3 cm) were observed at seeding rate of 175 kg ha^{-1}+ 46 kg N ha^{-1} rate constantly increased followed by 73.2cm at seeding rate of 69 kg N ha^{-1} + 92 kg N ha^{-1} while the smallest plants (68.9cm) were recorded at seeding rate of 125kg ha^{-1}+0kg N ha^{-1} but there was statistically not significantly different within all treatments across the multi-locations (Table 4). Chandra *et al*. (1992) concluded that plant height increased significantly by increasing nitrogen levels. The results indicated that increased nitrogen application had pronounced effect on increasing vegetative growth of crop pants. These results coincide with the findings of Rahel and Fekadu (2016) and Amare (2017) who reported that an increase in seeding rate could result in reduced plant height of bread wheat. Bungard *et al.* (2002) stated that nitrogen is a constituent of many fundamental cell components and it plays a vital role in all living tissues of the plant. They reported that increase in height could be attributed to its involvement as building blocks in the synthesis of amino acids, as they link together and form proteins and make up metabolic processes required for plant growth. No other element has such an effect on promoting vigorous plant growth than nitrogen. This indicated that nitrogen played a more prominent role in increasing plant height than the other fertilizers (Zeidan *et al*., 2006).

Tiller per plant

Neither the main effects nor the combined mean effects of nitrogen and seeding rate had a significant influence on total tiller per plant and productive tiller per plant of irrigated wheat across all locations (Table 4).

Spike Length (cm)

The main effect of nitrogen rate as well as the combined mean effect of the two factors significantly ($P < 0.05$) influenced spike length, whereas, the main effect of the seeding rate did not influence this parameter of the crop plant (Table 4). Maximum spike length (8.38cm) was observed at seeding rate of 150 kg ha^{-1} + 23 kg N ha^{-1} followed by at seeding rate 175kg ha^{-1} + 46kg N ha^{-1} (8.35cm) and at seeding rate 150kg ha^{-1} + 92 kg N ha^{-1} (8.31cm), while minimum spike length (7.55cm) was recorded at seeding rate of 125 kg ha^{-1} + 23 kg N ha^{-1} (Table 4). These results are in agreement with those of Hussain *et al*. (2001) and Ahmad *et al.* (2000) reported that the spike length of wheat was increased significantly with increasing nitrogen levels and the seeding rate increased spike length of food barley at optimum level.

Grain per spike

The results indicated that the main effect of seed rate and nitrogen rate did not significantly ($P < 0.05$) influenced seed spike^{1}. However, the combined mean effect of the two factors significantly ($P < 0.01$) influenced irrigated wheat seed spike^{1} across all locations (Table 5). Maximum (52.58) seed spike^{1}were observed at seeding rate of 175 kg ha^{-1} +0kg N ha^{-1} followed by 47.56 at the rate of 125kg ha^{-1} seed rate +92 kg N ha^{-1} and 45.31 at the rate of 150kg ha^{-1}+0kg ha^{-1} N, while minimum number of seed spike^{-1}(41.03) were recorded at the rate of 150 kg ha^{-1} seed rate+ 23 kg N ha^{-1} rate though there was statistically not significant differences recorded in all treatments across the location (Table 5). Similar results were also reported by Marwat et al., (1989), who reported that higher seed rates produced significant decrease in the number of grains spike^{1}and similar studies were also reported in agreement with Ibrar. (1999) and Geleto et al., (1995), who reported that grains spike^{-1} increased at 120 kg N ha^{-1}.

Table 4: Combined mean effect of seed and nitrogen rates on phenological and growth traits of irrigated wheat in lowlands of Oromia

Seed Rates (kg ha^{-1})	Nitrogen Rates (kg ha^{-1})	Days to Heading	Days to Maturity	Plant Height (cm)	Total Tillers /plant	Productive Tillers/plant	Spike Length (cm)
125	0	57.3^{ef}	101.4^{c}	68.92^{ab}	7.00	6.00	7.59^{bc}
125	23	57.3^{ef}	101.7^{c}	70.73^{ab}	8.00	7.00	8.38^{a}
125	46	57.3^{ef}	103.1^{bc}	73.12^{a}	8.00	7.00	8.02^{abc}
125	69	58.7^{bcd}	102.7^{bc}	71.42^{ab}	8.00	7.00	8.15^{ab}
125	92	57.6^{def}	102.5^{bc}	72.55^{ab}	7.00	7.00	8.31^{a}
150	0	57.1^{f}	101.7^{c}	70.62^{ab}	7.00	6.00	8.06^{abc}
150	23	57.1^{f}	101.4^{c}	66.89^{b}	8.00	7.00	7.55^{c}
150	46	59.5^{ab}	103.7^{ab}	70.64^{ab}	7.00	6.00	8.07^{abc}
150	69	58.4^{b-e}	103.9^{ab}	71.16^{ab}	7.00	6.00	8.07^{abc}
150	92	59.1^{abc}	104.0^{ab}	73.23^{a}	7.00	6.00	8.21^{a}
175	0	57.8^{c-f}	101.7^{c}	69.09^{ab}	8.00	7.00	7.62^{bc}
175	23	57.7^{def}	101.7^{c}	70.19^{ab}	7.00	6.00	8.13^{ab}
175	46	60.3^{a}	105.7^{a}	73.32^{a}	7.00	6.00	8.35^{a}
175	69	59.1^{abc}	102.7^{bc}	70.05^{ab}	7.00	6.00	8.24^{a}
175	92	59.6^{ab}	105.7^{a}	72.86^{ab}	8.00	6.00	7.84^{abc}
LSD(p<0.05)		**1.32**	**1.88**	**7.26**	**NS**	**NS**	**0.56**
CV (%)		**3.32**	**2.54**	**14.13**	**29.93**	**32.08**	**9.74**

Means followed by the same letter(s) for the same parameter are not significantly different from each other at 5% level of significance.

1000 grain weight (g)

Neither the main effects nor the combined mean effects of nitrogen and seeding rate had no significant influence on the 1000 grain weight of the wheat across all location (Table 5).

Biological yield (t ha^{1})

The main effects of nitrogen and seed rates significantly (P < 0.01) influenced the biological yield (t ha^{-1}) of irrigated wheat across all locations (Table). Similarly, the combined effect of nitrogen and seed rates significantly (P < 0.05) affected biological yield (t ha^{-1}) of irrigated wheat (Table 5). The highest biological yield (8.75 t ha^{1}) was obtained at seed rate of 175kg ha^{-1} +69 kg ha^{-1} N rate, though no significant differences (8.40 ha^{-1}) was recorded with rate of 125 kg ha^{-1} seed rate + 69kg N ha^{-1} rate, while lowest biological yield was recorded at the rate of 125kg ha^{-1} seed rate + 0 kg ha^{-1} N rate. However, no significant variations were observed among treatments across locations (Table 5). Biological yield represents the overall growth performance of the plant as well as the crop and is considered to be the essential yield parameter to get useful information about the overall growth of the crop of wheat. The increase in biological yield with an increase in nitrogen levels may be due to the effect of nitrogen on the vegetative growth of wheat as well as an increase in tillers number with higher rates of nitrogen. In addition, high seeding rates might also increase early dry matter accumulation and weed competitiveness, this report was agreed with (Park *et al*., 2003). Increased in biomass production might be attributed to the increased plant population due to a higher seeding rate with better nitrogen application. These results are in agreement with Islam *et al.,* (2002), Mojiri and Arzani (2003) and Soylu *et al*., (2005). Otteson *et al.* (2007) found that biological yield was increased by increasing nitrogen up to optimum levels which is may be due to encouragement of vegetative growth by the application of high N fertilizer (Albert *et al.,* 2005). Nayyar *et al.* (1992) obtained the highest biological yield at higher seeding rate of 100 kg/ha.These results are in agreement with Marwat et al., (1989), Ghaffar and Shahidullah (1987) stated that the increase in biological yield with higher seed rate might be due to more number of plants per unit area, though with reduced tillers.

Grain yield (t ha^{-1})

The analysis of variance revealed that the main effects of nitrogen and seed rates significantly (P < 0.01) influenced grain yield (t ha^{-1}) of irrigated wheat across all locations. Similarly, the combined mean effect of nitrogen and seed rates significantly (P < 0.05) affected grain yield (t ha^{-1}) of irrigated wheat (Table 5). The highest grain yield (4.09 t ha^{1}) was obtained at the seed rate of 125kg ha^{-1} + 69 kg N ha^{-1} rate, though no significant differences (4.01 t ha^{1}) was recorded with rate of 150 kg ha^{-1} seed + 92kg N ha^{-1} rate and (3.97 t ha^{1}) at the rate of 175 kg ha^{-1} seed rate +92 kg N ha^{-1} rate, While, the lowest grain yield was recorded at 125kg ha^{-1} seed rate + 0 kg ha^{-1} N rate. The result indicated that seed rate could affect the grain yield of irrigated wheat. The increase in yield of the irrigated wheat with increasing N rates up to an adequate level might be due to the role of N in increasing the leaf area and promoting photosynthesis efficiency which promote dry matter production and increase yield. These results are in agreement with Chatta *et al.* (1986), Ibrar (1999), Hameed *et al.* (2003) and Ijaz *et al.* (2003), who reported that grain yield of bread wheat increased as seed rate increased. In line with this, improvements in wheat yield and its components under the acceptable increasing N rates were reported by Sticksel *et al*. (2000).

Table 5: Combined mean effect of seed and nitrogen rates on yield and yield components

Seed Rates (kgha^{-1})	Nitrogen Rates (kgha^{-1})	Grain spike^{-1}	1000grain Weight (g)	Biological Yield (tha^{-1})	Grain yield (t ha^{-1})	Harvest Index (%)
125	0	43.02^{b}	35.88	6.23^{e}	3.01^{f}	47.39^{ab}
125	23	43.02^{b}	35.05	$7.61^{a\text{-}d}$	3.52^{bcd}	46.13^{ab}
125	46	44.88^{b}	35.41	$7.702^{a\text{-}d}$	3.78^{abc}	48.60^{ab}
125	69	45.30^{ab}	35.98	8.40^{ab}	4.09^{a}	49.65^{a}
125	92	47.55^{ab}	34.78	7.92^{abc}	3.92^{ab}	49.49^{ab}
150	0	43.46^{b}	36.07	6.60^{cde}	3.07^{ef}	46.37^{ab}
150	23	41.03^{b}	35.79	$7.21^{b\text{-}e}$	$3.38^{c\text{-}f}$	48.15^{ab}
150	46	41.52^{b}	36.88	$7.51^{a\text{-}e}$	$3.48^{b\text{-}e}$	45.95^{ab}
150	69	43.19^{b}	35.88	8.11^{ab}	3.82^{ab}	46.64^{ab}
150	92	43.00^{b}	35.94	7.98^{ab}	4.01^{a}	50.33^{a}
175	0	52.58^{a}	36.17	6.46^{de}	3.05^{ef}	46.64^{ab}
175	23	42.06^{b}	35.04	$7.31^{b\text{-}e}$	3.33^{def}	46.48^{ab}
175	46	45.10^{b}	35.13	7.93^{abc}	$3.74^{a\text{-}d}$	47.01^{ab}
175	69	42.30^{b}	35.69	8.75^{a}	3.83^{ab}	44.24^{b}
175	92	45.10^{b}	34.38	8.20^{ab}	3.96^{a}	48.39^{ab}
LSD(p<0.05)		**7.31**	**NS**	**1.37**	**0.43**	**5.29**
CV (%)		**22.90**	**9.99**	**25.07**	**16.91**	**15.45**

Means followed by the same letter(s) for the same parameter are not significantly different from each other at 5% level of significance

Harvest Index (%)

The analysis of variance indicated the main effects of nitrogen and seed rates significantly (P < 0.01) influenced the harvest index (%) of irrigated wheat across all locations. Similarly, the combined effect of nitrogen and seed rates significantly (P < 0.05) affected harvest index (%) of irrigated wheat (Table 5). Maximum harvest index (50.33) was obtained at seed and N rate of 150 kg ha^{-1} + 92 kg N ha^{-1} rate, respectively. However, no significant variation was observed in all treatments except for the rate of 175 kg ha^{-1} seed + 92kg N ha^{-1} that records minimum harvest index (Table 5). The capacity of a crop to convert the dry matter into economic yield is indicated by its harvest index. The higher the harvest index value, the greater the physiological potential of the crop for the converting dry matter to grain yield. The result might indicated increased seed rate at optimum and increased the N rate might increase harvest index (%) which was supported by the findings of Singh *et al.* (2002) which reported that an increase in nitrogen level increased harvest index. The result that was recorded as there was no significant differences in all treatments could be due to partitioning of the total nitrogen content more to the vegetative part of the crop than to the grain and increased the total aboveground biomass yield with the application of nitrogen.

Economic analysis

The partial budget analysis for means of treatment was assessed, and data presented in the table (6) indicated that the economic analysis of wheat as affected by various levels of seed rates and N fertilizer. The data revealed that the maximum net benefit (90532.23 ETB) with acceptable marginal rate of return (MRR %) 870.3% was attained when 150 N kg.ha^{-1} that was planted with 125 kg.ha^{-1} of seed rate of wheat. However, the lowest net income (66593.35 ETB), was obtained from the control plots received null N fertilizer application with seed rate of 175kg ha^{-1}. Thus, 69 kg·N·ha^{-1} which was sown at the 125 kg·ha^{-1} seed rate is the best rate and economically feasible for irrigated bread wheat production in Eastern and south eastern lowlands of Oromia, Ethiopia.

Table 6. Economic analysis of wheat as affected by various seed rates and different N levels

SD	Ur	MGY	Adj.GY	TVC	GB	NB	DA	MRR%
125	0	3010	2709	11103	78100.47	66997.47		
125	23	3520	3168	13932	91333.44	77401.44		367.76
125	46	3780	3402	14762	98079.66	83317.66		712.79
125	69	4090	3681	15591	106123.23	90532.23		870.27
125	92	3920	3528	16421	101712.24	85291.24	D	
150	0	3070	2763	11824	79657.29	67833.29		
150	23	3380	3042	14653	87700.86	73047.86		184.33
150	46	3480	3132	15483	90295.56	74812.56		212.61
150	69	3820	3438	16412	99117.54	82705.54		849.62
150	92	4010	3609	17142	104047.47	86905.47		575.33
175	0	3050	2745	12545	79138.35	66593.35	D	
175	23	3330	2997	15374	86403.51	71029.51		
175	46	3740	3366	16504	97041.78	80537.78		841.44
175	69	3830	3447	17033	99377.01	82344.01		181.69
175	92	3960	3564	17863	102750.12	84887.12		306.40

Key: SD= seed rate kg/ha Ur= Urea rate kg/ha, MGY= mean Grain Yield kg/ha, Adj.GY= Adjusted Grain yield by 10 %, GB= Gross benefit NB= Net benefit, DA= Dominance Analysis, D= Dominated treatment, MRR=Marginal Rate of Return

SUMMARY AND CONCLUSIONS

Dryland variety-specific agronomic packages are not necessarily valid in irrigated cropping systems. Thus, there is a need for further research in irrigated farming systems. Irrigated wheat yields are primarily determined by how well the crop's requirements for growth are met and yield-reducing factors such as poor plant nutrition and seed rate are minimized. The analytical results of the experimental soil indicated that the soil textural class is sandy loam at Adami Tulu, silt loam at Lume and sandy clay loam at Bedeno. The soil was moderately alkaline, low in organic carbon, low in available P and low in total N. The most prolonged duration to reach 50% flowering and heading was observed in response to the combined mean effect of 46 kg N ha^{-1} with 175 kg ha^{-1} seed rate. Plant height was significantly altered by the combined mean effects of N and seed rate with maximum response at 46 kg N ha^{-1} with a seeding rate of 175 kg ha^{-1}. Neither the main effects nor the combined mean effects of nitrogen and seeding rate had a significant influence on total tiller per plant, productive tiller per plant and thousand grain weight of irrigated wheat across all locations. The Maximum spike length was observed at a seeding rate of 69 kg ha^{-1} with 23 kg N ha^{-1} whereas the optimum seed per spike was obtained at seeding rate of 175 kg ha^{-1} with 0 kg ha-^{1} N rate. The highest grain yield, harvest index and optimal biological yield were obtained at the seeding rate of 125kg ha^{-1} with 69 kg N ha^{-1} rate across multi-locations. The results generally showed that application of nitrogen at the rate 69 N kg ha^{-1} with a seeding rate of 125kg ha^{-1} proved to be optimum for higher grain yield of irrigated wheat in lowland areas of Oromia. There was no need to increase nitrogen application rates and seeding rate beyond this one since both growth and yield did not improve with further increases in the rate of the fertilizer and seed. The economic analysis revealed that for a treatment to be considered worthwhile to farmers (100% marginal rate of return), application of 69 kg N ha^{-1} with 125kg ha^{-1} seed rate N are economically feasible and recommended for farmers in the study area and similar agro-ecologies. In conclusion, the application of 69 kg ha^{-1} N rate and 125kg ha^{-1} seed rate resulted in the best results in terms of plant growth and yields for irrigated wheat production in the study areas.

ACKNOWLEDGMENTS

The authors are grateful to Oromia Agricultural Research Institute for allocating required budget and technical support. The authors would also like to extend their gratitude to all staff members of Sinana, Fadis and Adami Tulu Agricultural Research Center for their assistance in setting up, planting, collecting the data, and maintaining the field experiments. All the stakeholders and irrigated wheat technical committee involved in LSD were also acknowledged.

REFERENCES

1. AGRA. (2018). Africa agriculture status report: Catalyzing government capacity to drive agricultural transformation (Issue 6). Anne Marie Nyamu, Editorial, Publishing and Training Consultant.
2. Ahmad, M.M., N. Yousaf and M.S. Zamir, 2000. Response of wheat growth, yield and quality to varying application of nitrogen and phosphorous. J. Agric. Res., 38: 289-29.
3. Albert, S., K. Skirvin, and D. Long, 2005. Winter wheat responses to nitrogen fertilization in a direct-seed, summer fallow management system. pp. 87-91. In: D.A. Long, S.E. Pertrie and P.M. Frank (eds.). Dryland Agric Res. Annual reports. SR 1061. Corvallis.
4. Alemayehu Adinew. 2015. Effect of seed source and rates on productivity of bread wheat (Triticumaestivum L.) varieties at Kersa, Eastern Ethiopia. MSc. Thesis Presented to School of Graduate Studies of Alemaya University, Ethiopia. pp. 70.
5. Ali, A., M.A. Choudhry, M.A. Malik, R. Ahmad and Saifullah, 2000. Effect of various deoses of nitrogen on the growth and yield of two wheat cultivars. Pak. J. Biol. Sci., 3: 1004-1005.

6. Amentae, T. Hamo, T. , Gebresenbet, G.&Ljungberg D. (2017). Exploring wheat value chain focusing on market performance, post-harvest loss and supply chain man-agement in Ethiopia: The case of Arsi to Finfinnee market chain. Journal of Agricultural Science, 9(8), 22.
7. Amare Assefa. 2017. Response of Bread Wheat (Triticumaestivum L.) varieties to different seeding rate for growth, yield and yield components in Kombolcha District, Northeastern Ethiopia. Journal of Biology, Agriculture and Healthcare.7 (23): 79–91.
8. Asadallah, N. (2014). Wheat production price perfor-mance prediction in the Iranian north province.African Journal of Agricultural Research, 9(1), 74–79.
9. Campillo, R., C. Jobet, and P. Undurraga. 2010. Effects of nitrogen on productivity, grain quality, and optimal nitrogen rates in winter wheat cv. Kumpa-INIA in Andisols of Southern Chile. Chilean Journal of Agricultural Research 70:122-131.
10. Chatha, M.R., A. Mukhtar and M.A. Gill. 1986. Yield of wheat cultivars as affected by different seed rates under irrigated conditions. Pak. J. Agric. Res. 7 (4): 241-24
11. Chandra, S., M.L. Varshncy, J. Singh and S.K. Singh, 1992. Response of wheat varieties to different levels of nitrogen. Narendra Deva. J. Agric. Res., 7(1): 169-171. [Wheat, Barley and Triticale Absts., 11: 4321; 1994].
12. CIMMYT (International Maize and Wheat Improvement Center). 1988. From agronomic data to farmer recommendation: An Economic work Book. Mexico, D.F.: CIMMYT.
13. CSA(Central Statistic Agency) (2012). Agricultural sample survey report on area and production of major crops (Private peasant holdings, Meher season 2011/2012 (2005 E.C.)). The FDRE statistical bulletin, Volume VII.
14. CSA. (2014). Agricultural sample survey report on area and production of major crops. Statistical Bulletin Volume VI.
15. CSA. (2015). Agricultural sample survey report on area and production of major crops (Private peasant holdings, Meher season 2014/2015 (2007 E.C.)). The FDRE statistical bulletin Volume I.
16. CSA. (2016). Agricultural sample survey report on area and production of major crops (Private peasant holdings, Belg season 2015/2016 (2008 E.C.)). The FDRE statistical bulletin, Volume V.
17. CSA. (2018). Agricultural sample survey report on area and production of major crops (Private peasant holdings, Meher season 2017/2018 (2010 E.C.)). The FDRE statistical bulletin, Volume I.
18. CSA. (2019). Agricultural sample survey report on area and production of major crops (Private peasant holdings, Meher season 2017/2018 (2010 E.C.)). The FDRE statistical bulletin, Volume I.
19. CSA (2020). Agricultural sample survey report on area and production of major crops for the period 2019/2020 cropping season. Vol I. Statistical bulletin 587, Addis Ababa; 2020.
20. Deldon A.V. 2001. Yield and growth components of potato and wheat under organic nitrogen management. Journal of Agronomy, 93: 1370-1385.
21. Ejersa, G. G. (2011). Contributions of vegetable production to the household food security: The case of Kebeles surrounding Holeta Town [MSc Thesis]. Adiss Ababa University.
22. Falola, A., Achem, B. A., Oloyede, W. O., &Olawuyi, G. O. (2017). Determinants of commercial production of wheat in Nigeria: A case study of Bakura local government area, Zamfara state. Trakia Journal of Sciences, 15(4), 397–404. https://doi.org/10.15547/ tjs.2017.04.024.
23. FAO. (2014). Analysis of price incentives for wheat in Ethiopia. Technical notes series, MAFAP, by Wakeyo M.B., Lanos B.
24. Frederick J.R. and Camberato J.J. 1995. Water and nitrogen effects on winter wheat in the south eastern coastal plain: II. Physiological response. Journal of Agronomy, 87: 527-532.
25. Frink, C.R., P.E. Waggoner and J.H. Ausubel, 1999. Nitrogen fertilizer: Retrospect and prospect. Proc. Natsl. Acad. Sci. (USA), 96: 1175-1180.
26. Geleto, T., D.G. Tanner, T. Mamo and G. Gebeyehu. 1995. Response of rainfed bread and durum wheat to source, level and timings of nitrogen fertilization on two Ethiopian vertisols. Comm. Soil Sci. & Plant Analys. 26 (11): 17773-17794.
27. Ghaffar, M.A. and M. Shahidullah. 1987. Study on the effect of phosphorus and seed rate on the performance of wheat. Sarhad J. Agric. 5 (2): 119-128.
28. GobezeLoha. 1999. Effect of special arrangement and nitrogen fertilizer application on (Sorghum bicolorL. Moench) and ground nut (ArachishypogaeaL.) intercrop system in Eastern Ethiopia. MSc Thesis, Alemaya University of Agriculture, Alemaya, Ethiopia.
29. Gwal, H.B., R.J. Tiwari, R.C. Jain and F.S. Prajapati, 1999. Effect of different levels of fertilizer on growth, yield and quality of late sown wheat. RACHIS Newsletter, 18: 42-44.
30. Hameed, E., S.A. Wajid, A.A. Shad, J. Bakht and T. Muhammad. 2003. Effect of different planting dates, seed rates and nitrogen levels on wheat. Asian J. Plant Sci. 2(6): 464-474.
31. Hirzel, J., I. Matus, and R. Madariaga. 2010. Effect of split nitrogen applications on durum wheat cultivars in volcanic soil. Chilean Journal of Agricultural Research 70:590-595.
32. Hussain, S., A. Sajjad, M.I. Hussain and M. Saleem, 2001. Growth and yield response of three wheat varieties to different seeding densities. Int J. Agric. Biol., 3: 228-229.
33. Ibrar, K. 1999. Effect of seed rates and nitrogen levels on wheat. M. Sc (Hons) thesis, Deptt. ofAgron. Agric. Univ. Peshawar, Pakistan.
34. I.jaz, A.K., J. Bakht, S.A. Wajid, N.M. Khan and I. Ullah. 2002. Effect of seed rate on the yield and yield components of wheat under irrigated conditions of Peshawar. Asian J. Plant Sci. 1: 513-515.
35. Islam, Z.U., S. Khan, J. Bakhat and W.A. Shah, 2002. Frequency of various nitrogen levels, lodging and seed quality in wheat. Asian J. Plant Sci., 1: 510-512.
36. Jackson ML (1962) Soil chemical analysis. New Delhi, Prentice Hall of India Pvt. Ltd p: 498.
37. Jackson, M.L. 1967. Soil Chemical Analysis, Prentice Hall of India, Pvt. Ltd., New Delhi.
38. Kiss, I. (2011). Significance of wheat production in world economy and position of hungary in it. Abstract: Applied studies in agribusiness and commerce [Thesis]. University of Debrecen.
39. Kristó, I., K. Gyuris, M. Torma, M. Hódi-Szél, and I.M. Petróczi. 2007. Investigation of sowing date and seeding rate on the yield of winter wheat. Cereal Research Communications 35:685-688.

40. Lacy J, Giblin K (2006) Growing eight tonnes per hectare of irrigated wheat in southern NSW. Primefact 197. NSW Department of Primary Industries, Orange, NSW.
41. Lake Mekonnen. 2018. Effects of seed and N rate on grain yield and yield components of barley. Journal of Natural Sciences Research, 8 (3): 10–15.
42. Makowski, D., D. Wallach and J.M. Meynard, 1999. Model of yield, grain protein and residual mineral nitrogen responses to applied nitrogen for winter wheat. Agron. J., 91: 337-385.
43. Manna, M.C., Swarup, A., Wanjari, R.H., Ravankar, H.N., Mishra, B., Saha, M.N., Singh, Y.V Sahi, D. K. and Sarap, P.A. 2005. Long-term effect of fertilizer and manure application on soil organic carbon storage, soil quality and yield sustainability under sub-humid and semi-arid tropical India. Field Crops Research, 93:264-280.
44. Maric, S., V. Guberac, G. Drezner, S. Petrovic, T. Cupic, and V. Brandic. 2008. Effects of testing environments and crop density on winter wheat yield. p. 684-686. In Appels, R., et al. (ed.) Proceedings of the 11th International Wheat Genetics Symposium, Brisbane, Queensland, Australia. 24-29 August 2008. Sidney University Press, Sidney, Australia.
45. Marwat, A.Q., S.K. Khalil, A.L. Wazir and M. Iqbal. 1989. Effect of land preparation and seeding rates on plant height and straw yield on wheat. Sarhad J. Agric. 5 (3): 273-278
46. Matouš, P., Todo, Y., & Mojo, D. (2013). Roles of extension and ethno-religious networks in acceptance of resource-conserving agriculture among Ethiopian farmers. International Journal of Agricultural Sustainability, 11(4), 301–316.
47. Minot, N., Warner, J., Lemma, S., Kasa, L., Gashaw, A., & Rashid, S. (2015). The wheat supply chain in Ethiopia: Patterns, trends, and policy options. International Food Policy Research Institute (IFPRI).
48. MoARD (Minstry of Agriculture and Rural Development). 2013. Cereal crop production and protection manual in the highland area. Addis Ababa, Ethiopia.
49. Mojiri, A. and A. Arzani, 2003. Effects of nitrogen rate and plant density on yield and yield components of sunflower. J. Sci. Technol. Agric. Nat. Resour., 7: 115-125.
50. Mulatubayeh and Grando Stefania (Eds.). 2011. Barley Research and Development in Ethiopia. Proceedings of the 2nd National Barley Research and Development Review Workshop 28-30 November, 2006. HARC, Holetta, Ethiopia. ICARDA. Aleppo, Syria, pp. xiv + 391.
51. Nayyar, M.M., M. Asghar and M.J. Tahir, 1992. Effect of sowing date and seeding rate on wheat grain yield under irrigated conditions. J. Agric. Res., 30: 329- 333.
52. Nazir, M.S., A. Jabbar, Z. Waheed, A. Gaffar and M. Aslam, 2000. Response of late sown wheat to seeding density and nitrogen management. Pak. J. Biol. Sci., 3: 998-1001
53. NBE. (2018). National bank of Ethiopia 2017/2018 annual report. National bank of Ethiopia.
54. Negassa, A., Shiferaw, B., Koo, J., Sonder, K., Smale, M., Braun, H. J., Gbegbelegbe, S., ZheGuo, D. H., Wood, S., Payne, T., &Abeyo, B. (2013). The potential for wheat production in Africa: Analysis of biophysical suitability and economic profitability. International Maize and Wheat Improvement Center (CIMMYT).
55. Nikolic, O., T. Zivanovic, M. Jelic, and I. Djalovic. 2012. Interrelationships between grain nitrogen content and other indicators of nitrogen accumulation and utilization efficiency in wheat plants. Chilean Journal of Agricultural Research 72:111- 116.
56. Otteson, B.N., M. Mergoum and J.K. Ransom, 2007. Seeding rate and nitrogen management effects on spring wheat yield and yield components. Agron. J., 99: 1615-1621.
57. Otteson, B.N., M. Mergoum, and J.K. Ransom. 2008. Seeding rate and nitrogen management on milling and baking quality of hard red spring wheat genotypes. Crop Science 48:749-755.
58. Ozturk, A., O. Caglar and S. Bulut, 2005. Growth and yield response of facultative wheat to winter sowing, freezing sowing and spring sowing at different seeding rates. J. Agron. Crop Sci., 192: 10-16.
59. Park, S.E., L.R. Benjamin, and A.R. Watkinson. 2003. The theory and application of plant competition models: an agronomic perspective. Annals of Botany 92:471-478
60. Piper, C.S. 1966. Soil and Plant Analysis, Academic Press, New York, pp.47-77.
61. Syers JK, Craswell ET, Nyamudeza P (2001). Research Needs and Opportunities for farming Vertisols Sustainably. In ed. Syers JK, penning FW, Nyamudezap(2001). The Sustainable Management of Vertisols. CABI Publishing. New York. USA.
62. Rahel Tigabu and Fekadu Asfaw. 2016. Effects of seed rate and row spacing on yield and yield components of Bread Wheat (Triticumaestivum L.) in DalboAwtaru Woreda, Wolaita Zone southern Ethiopia. Journal of Biology, Agriculture and Healthcare, 6: 61-62.
63. Selamyihun K, Tanner DG, Tekalign M. Residual efects of nitrogen fertilizer on the yield and N composition of succeeding cereal crops and on soil chemical properties of an Ethiopian highland Vertisol. Can J Soil Sci. 2000;80:63–9.
64. Shah, Z., W. Muhammad, M. Afzal and W. Mohammad. 1997. Yield and N content of wheat as influenced by nitrification inhibitor. Scient. Khyber. 10: 1-2.
65. Singh, C.B., J. Kumar, A.A. Khan, R.A. Katiyar and A.K. Katiyar, 2002. Effect of nitrogen and dates of sowing on yield and quality of wheat (Triticumaestivum L.) seeds. Progressive Agric., 2: 92-93.
66. Soylu, S., B. Sade, A. Topal, N. Akgun and S. Gezgin, 2005. Response of irrigated durum and bread wheat cultivar to boron application in a low boron calcareous soil. Turk. J. Agri., 29: 275-286
67. Sticksel E, Maidl F-X, Retzer F, Dennert J, Fischbeck G. Efciency of grain production of winter wheat as afected by N fertilisation under particular consideration of single culm sink size. Eur J Agron. 2000;13:287–94.
68. Tekalign M, Haque I, kamara GS (1988). Phosphorus status of some Ethiopian highland vertisols. In prodeeding of managment of vertisols in the sub-saharan Africa. International livestock Center for Africa, Addis Ababa.Ethiopia.
69. Valério, I.P., F.I. Félix de Carvalho, A. Costa de Oliveira, G. Benin, V. Queiroz de Souza, A. de Almeida Machado, et al. 2009. Seeding density in wheat genotypes as a function of tillering potential. Scientia Agricola (Piracicaba, Brazil) 66:28-39.

70. Zecevic, V., D. Knezevic, J. Boskovic, D. Micanovic, and G. Dozet. 2010. Effect of nitrogen fertilization on winter wheat quality. Cereal Research Communications 38:243-249
71. Zeidan M.S., Amany A., Bher El-Kramany, M.F. 2006. Effect of Nitrogen Fertilizer and Plant Density on Yield and Quality of Maize in Sandy Soil. INSI net Publication, 2(4): 156-161.

How to cite this article
Biri, A., Tadesse, F., Mengistu, G., Meleta, T., Bogale, M., Balcha, U., & Dinsa, T. (2023). Response of Nitrogen Fertilizer and Seed Rates on Growth, Yield and Yield Components of Irrigated Bread Wheat in the lowlands of Eastern and South Eastern of Oromia, Ethiopia. Int J Agric Life Sci, 9(3), 403-413. doi: 10.22573/spg.ijals.023.s122000115.

CONFLICTS OF INTEREST

“The authors declare no conflict of interest”.