EFFECT OF NPS AND UREA FERTILIZER COMBINED APPLICATION ON WHEAT YIELD AND YIELD RELATED FRUITS IN BULE HORA DISTRICT, SOUTHERN ETHIOPIA

MSC THESIS

BY

DEME MEGERSA JIDA

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DEME MEGERSA JIDA

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Chairperson CGS _____Signature_____ Date _____

DEDICATION

This thesis is dedicated to my beloved parents, my Mother Gete Tola ,My brather Guta Megeresa, Kasahun Megersa and my sister Sena Megersa , my wife Tigist Beyena,whose unwavering support and sacrifices have been instrumental in my success.

STATEMENT OF THE AUTHOR

This is to certify that this thesis allowed Response of Bread Wheat to NPS and Urea Fertilizer in Bule Hora District, Southern Ethiopia. The thesis is submitted in partial fulfillment of the requirements for the award of the degree of Master of Science in Agronomy to the Graduate Program of College of Agriculture and Veterinary Medicine, Jimma University by Mrs. Deme Megersa Jida (RM0661/14.0) is a dependable work carried out by his under our guidance. The matter embodied in this thesis work has not been submitted previous for award of any degree or diploma to the best of our knowledge and belief.

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BIOGRAPHICAL SKETCH

The author, Deme Megersa Jida, was born on 16, 1989 from his father Megersa Jida and mother Gete Tola, in Digalu Tijo District, Arsi Zone, Oromia National Regional State. He attended elementary school (1 – 8 grades) at Digalu Elementary Echool. He pursued secondary and preparatory education (9 - 12) at Sagure Secondary and Preparatory School. After passing the Ethiopian General Secondary Education Certificate Examination (EGSECE), he joined Wolaita Soddo University in 2010 and graduated with the Degree of Bachelor of Science (BSc) in Plant Sciences in July 2012,GC**.** After graduation, he was employed by Oromia Agriculture Research Institute, Yabello Pastoral and Dry Land Agricultural Research Center (YPDARC) as a Junior Researcher since, 2017. At Yabello Pastoral and Dry Land Agricultural Research Center (YPDARC), he worked as a Seed Researcher and Technology Multiplication Case Team until he joined Jimma University in November 2022, GC to pursue a study leading to the Degree of Master of Science in Agronomy.

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ACRONYMS AND ABBREVIATIONS

ANOVA	Analysis of Variance
AP	Available Phosphorous
AS	Available Sulphur
BHD	Bule Hora District
BHT	Bule Hora Town
BHWAO	Bule Hora Woreda Agriculture Office
BW	Bread Wheat
CAVM	Cllege of Agriculture and Veternary Medicne
CEC	Cation Exchange Capacity
CIMMYT	Centro International de Mejoramiento de Maize y Trigo
CIMMYT	International Maize and Wheat Improvement Center
CSA	Central Statistics Agency of Ethiopia
ENM	Ethiopia National Meteorology
ETB	Ethiopia Birr
FAOSTAT	Food and Agriculture Organization Corporate Statistical Database
GB	Gross Benefit
GLM	Generalized Linear Model
JARC	Jimma Agriculture Research Center
JU	Jimma University
LSD	List Significance Difference
MOA	Minstery of Agriculture of Ethiopia
MOANR	Ministry of Agriculture and Natural Resource of Ethiopia
MRR	Marginal Return Rate
NI	Net Income
OARI	Institute of Oromia Agricultural Research
OC	Organic Carbon
OM	Organic Matter
PG	Post Graduate
SAS	Statistical Analysis of Software

TGI	Total Gross Income
TN	Total Nitrogen
TVC	Total Variable Cost
WGZ	West Guji Zone
YPDARC	Yabello Pastoral and Dry Land Agriculture research Center

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EFFECT OF NPS AND UREA FERTILIZER COMBINED APPLICATION ON WHEAT YIELD AND YIELD RELATED FRUITS IN BULE HORA DISTRICT, SOUTHERN ETHIOPIA

ABSTRACT

*Bread wheat is one of the key food crops in the study area and grown for home consumption, market and strategic crop to address food security in Ethiopia. However, the productivity and yield is mostly constrained by soil fertility and lack of better fertilizer rate in the study area. The study was conducted at Bule Hora District, southern Ethiopia during the main cropping season of 2023. The study was aimed to determine the combined application of NPS and Urea(N) fertilizer rate for bread wheat (Triticum aestivum L.) production and to identify the optimum fertilizer for higher grain yield with the higher economic return. The treatments were: (0 NPS)negative control, 60Kg NPS, 120kg NPS, and 180 kg NPS) and (0N)negative control, 140kgN, 280kg N) and positive control (100/100kg ha^{-1} NPS/ N). The treatments were arranged in a randomized complete block design and replicated three times. Soil samples for the experimental site were taken before sowing and post harvesting for soil physicochemical analysis. All data (Phenological, growth, Yield and yield parameters were collected and analyzed using GLM procedure of SAS (Version 9.3) and means differences were tested for the significance with least significant difference (LSD) method at 0.05 probability level. The results of analysis of variance for agronomyic characters indicated that the effect of fertilizer application rates were significant for date of 50% heading,date of 90% physiological maturity, plant hight, number of total tiller per plant, spike length per plant, effective tiller per plant, spikelet per spike, number of grain per spike, thausands seed weight, hareves index,above graound biomass,Straw Yield and grain yield). The maximum duration of 50% days to heading (*83.67days*), day to 90% physiological maturity (136days) were obtained from unfertilized whereas the minimum duration of 50% day to heading (70.33days), day to 90% physiological maturity (120 days) were obtained from 180 kg NPS ha^{-1} + 280 kg N ha^{-1} fertilizer rates, respectively. The maximum plant height (92.21cm), effective tiller per plant (5.21), number of total tiller per plant (5.25), spike length (9.21cm) ,grain yield 4433 kg were obtained from 180 kg NPS ha^{-1} + 280 kg N ha^{-1} fertilizer rates, respectively. The maximum spikelet per spike(19) and number of grain per spike(74.67) were obtained from 120 kg NPS ha-1 + 140kg N ha-1 fertilizer rates, respectively. The maximum thousand grains weight (38.00 gm), harvest index (44.33%) were obtained from 180 kg NPS ha^{-1} + 140kg N ha^{-1} fertilizer rates, respectively. The maximum above-ground biomass (AGB) (13.33 ton), straw yields (10.077 ton) were obtained from 60kg NPS ha^{-1} + 140kg N ha^{-1} fertilizer rate. The results of economic analysis indicated that the maximum net benefit of 213489.73 ETB ha^{-1} and marginal rate of return (MRR) of 121479.6% were obtained due to the application of 120/140 kg ha^{-1} NPS/Urea(N). Therefore, 120/140 kg ha^{-1} NPS/* urea(*N) can be used by the farming community in the study area. However, the study is better conducted for more year in multiple locations to give conclusive recommendations.*

Key Words**:** *Bread wheat, Bule Hora District,Fertilizer rate,Ethiopia, Grain Yield*

1. INTRODUCTION

Wheat(*Triticum aestivum* L.*)*is one of about 300,000 potentially edible plant species, of which just over 100 are commonly cultivated. Of these, just three rice, wheat, and maize provide nearly 60% of all human calories, and wheat alone provides about 20% of all calories and protein(Erenstein *et al.,* 2022). Wheat is one of the most important cereal grains in the world, feeding more than one-third of the world's population(Beketa *et al.,* 2020) and the most widely grown food crop, with 761 Mt expected to be produced globally in 2020 to meet food demand by mid-center(Guarin *et al*.,2022).In addition, wheat is one of the world's most important agricultural products, a staple food crop, and a vital source of protein in developing nations(Rut-Duga, 2019).Potential increase in world wheat output from the projected 1.3 ± 0.7 t ha−1 yr−1 in 2020. The current production from low-rainfall areas (30% of the total global production in 2020) and the global average of bread wheat production and productivity (3.4 t ha−1) represent a 37% increase in production and yield (Assefa, *et al*., 2021; FAOSTAT, 2022).

The highlands of eastern Africa, which include Ethiopia, Eritrea, Kenya, Uganda, Rwanda, Burundi, and Tanzania, are important regions for growing wheat and have summertime rain-fed production systems.Wheat harvests were generated in Egypt, South Africa and Kenya, three African nations wheat yields of 67, 35, and 30 quintals per hectare, respectively, compared to Ethiopia's 28 qt/ha (Adugnaw and Dagninet, 2020). One of the most important agricultural products in the world is wheat. It now takes up more space than any other commercial crop and provides 19% of all the calories that people may consume. Similar to that, it is one of the most significant cereal crops grown throughout the world, including Ethiopia, in a variety of agro-ecologies(Mohammad and Golkari, 2022).More over one-third of the world's population relies on bread wheat (*Triticum aestivum* L.), the most common cereal grain (Terfa *et al*.,2020). With over 20% of all food consumed worldwide coming from wheat, it is the most significant grain crop in the world. For nearly a third of the world's population, it is a reliable source of food and ranks in the production of cereals (Brzegen and Http://hdl.handle.net/123, 2019)

It is a major grain crop used for both human and animal feed(Abera *et al.,* 2021), and it is processed into a wide range of traditional and contemporary foods, such as injera and other industrially processed goods(Nigussie *et al*., 2015). Ethiopia produces 5.5 Mt of wheat, or 21.7% of all wheat produced and 18.3% of all harvested wheat area in Africa(Senbeta and Worku,2023).People use the grain in many ways in both rural and urban regions. Ethiopia is the second-largest producer of wheat in Africa, behind Egypt. In addition, farmers sell wheat grain to generate income and pay for other costs. Wheat straw, on the other hand, is used for mulch, animal bedding, thatching house roofs, and compost as it breaks down(Arega and Setu, 2014).In the Ethiopian highlands, which range from 1500 to 2800 m.s.l. and between 60 and 16°N and 35 and 42°E, wheat is likewise the main grain crop.

One of the most significant crops for Ethiopia's food security, wheat is predicted to generate a record 2.85 tons per hectare. It is grown on 2.1 million hectares of land each year, producing 6.7 million tons in total(Tadesse *et al.,* 2022). At almost 500,000 hectares, Ethiopia is the second-largest wheat-growing region in Sub-Saharan Africa. The two main wheat species that are primarily cultivated in the country are durum wheat (*Triticum turgidum L*.) and bread wheat (*Triticum aestivum L.)* (Awash, 2019). Of the 125 nations that produce wheat worldwide, Ethiopia ranks 25th in terms of both productivity and area covered. According to FAOSTAT (2017), Ethiopia's wheat production is much less than that of the Netherlands (90.936 qt/ha), New Zealand (98.633 qt/ha), and Ireland (101.746 qt/ha). Ethiopia's economy is dominated by agriculture, especially subsistence and rain-fed agricultural(Beketa *et al.,* 2020).2.1 million hectares of wheat are planted with both irrigation and rainwater, producing 6.7 million tons of grain with an average productivity of 30.0 and 40.0 qt/ha, respectively(Haile *et al*., 2022; Tadesse *et al.,* 2022).

In a similar vein, one of the most important crops in the world and the most often farmed kind of wheat is bread wheat *(Triticum aestivum)(*Değirmenci *et al,* 2023).It is farmed at various elevations between 67° north and 45° south, although it is less prevalent in tropical regions(Govindan *et al,* 2023). In addition, bread wheat accounts for more than 80% of the country's total wheat area and is a staple food for many Ethiopians, providing over 15% of the caloric intake for the nation's approximately 90 million people, placing it second only to

maize and slightly ahead of teff, sorghum, and inset, which together account for 10-12% of total calories (Aboye and Teto,2022). One of the many cereal crops cultivated in Ethiopia's highlands is bread wheat (*Triticum aestivum*), which is mostly farmed in the southeast, central, and northwest of the country and makes up more than 85% of Arsi, Bale, and East Shewa (Abera and Adinew, 2020).Bread wheat, or *Triticum aestivum L.,* is a significant food crop in the study area. It is grown for both household and market consumption, and it is a crop that is important for addressing Ethiopia's food security as well as a major crop in the West Guji Highlands, where it grows in a variety of agro-ecologies and is important for both food security and income generation(Basha *et al*.,2021).

In the West Guji highland and midland, the most significant crops are maize, haricot bean, common bean, wheat, and barley. Bread wheat *(Triticum aestivum L.)*, is a valuable crop that farmers need for a variety of reasons, including food, cash, animal feed, and compost as it decomposes. Nevertheless, this region has low bread wheat production. The research area's current bread wheat yield is 32.23 qt/ha(Basha *et al.,*2021),while the average output and productivity are 2.5 t ha−1(Assefa*, et al.,* 2021),. This is insufficient for the Guji area's highlands.Because of the several circumstances.The research area's most yield-limiting agronomic practices, farmers' inadequate fertilizer use, crop management, diseases, a dearth of disease-resistant and adaptable varieties, low soil fertility, the absence of organic manure, a lack of knowledge about fertilizer application rates, improper land preparation, planting time, and plant density are some examples of these factors. Among them, one of the issues with agricultural production is soil fertility. The complicated feature of soil that most closely resembles plant nutrition control is soil fertility. In order to maximize crop nutrition both temporarily and permanently and to attain sustainable crop output, soil fertility a controllable soil property must be carefully managed.The capacity of a soil to sustain crop production is known as soil productivity, and it is based on a variety of physical, chemical, and biological characteristics. It is the part of total soil productivity that deals with the availability of nutrients in the soil and its capacity to supply nutrients for crop production both from internal reserves and external applications. It incorporates a number of soil characteristics, all of which have an impact on the availability and dynamics of nutrients. A good crop depends on the soil having a high level of natural or enhanced fertility

This lends support to the preceding issues. Soil may encourage plant growth and maximize agricultural output. It is one of the key variables that directly affects crop yield and quality (Selim, 2020). It also has a substantial influence on crop health and yield (Chaparro, *et al* 2012).

Fertilizers both inorganic and organic can improve this. Significant degradation and partially irreversible damage to the soil was caused by soil fertility issues such as increased concentration, intensification, and specialization of crop and livestock production without proper consideration of the natural site-specific soil and climate conditions. These processes included soil compaction, water, and wind. The capacity of the soil to support plant development and maximize agricultural output is known as soil fertility. You can improve this with both organic and inorganic materials.Limited application of chemical fertilizers, inadequate understanding of fertilizer timing and dosage, advancements in cultivars, and absence of further contemporary crop management tools. reduced wheat production due to weather, water, fertilizer management, and cultivars with lower soil fertility(Anderson and Schneider, 2010: Hoogenboom *et al.,* 2022). Deteriorating soil fertility is one of the biggest issues affecting Ethiopia's agriculture yield and output. The following elements play a role in the reduction of soil fertility:The main obstacles to sustainable grain production in Ethiopia's highlands include soil erosion, deforestation, ongoing agriculture of the same area, inadequate use of organic and inorganic fertilizers, and the decrease or abandonment of successful traditional soil restoration approaches(Abera and Adinew, 2020).Grain quality and economic yields are restricted by poor soil fertility and a lack of site-specific fertilizer recommendations; Ethiopia's low agricultural productivity and food insecurity are mostly caused by soil fertility loss (Beketa *et al*., 2020; Iticha *et al*., 2024).Lower crop yields(Hirel *et al.,*2018),might be the consequence of highly soluble nitrogen fertilizers, such urea, being lost from the soil plant system.It has been demonstrated that plants lacking in sulfur are less resilient to stress (Doberman and Fairhurst, 2000).

One of the primary artificial methods for enhancing soil fertility and agricultural production is fertilization, which may raise crop yields by at least 30 to 50%(Das and Mandal,2015;Itelima, *et al.,* 2018).The role of water, modern seeds, and fertilizer in raising yields. Fertilizer is a

crucial agronomic approach and an essential agricultural element that boosts productivity (Stewart *et al.,* 2005). When applied properly, fertilizer may improve crop quality and yields (Xiang *et al.,* 2008),while also promoting agricultural growth and development. The drive for increased agricultural output without using fertilizers in a balanced way created issues with the collapse of soil fertility. In addition to being largely to blame for the improvements in food production, inorganic fertilizers have shown to be a crucial tool in the fight against issues with soil fertility(Sigaye *al et.,*2022).A major factor in long-term crop output (Diriba *et al.,* 2019), is applying the appropriate amount of fertilizer based on crop requirements. Integrated nutrient management increases agricultural productivity(Jat *et al.,* 2015).Using varying amounts of mixed (NPS) and urea fertilizer has a considerable impact on all yield components of bread wheat (Sigaye *et al*.,2022). Balanced and suitable soil nutrient management is a vital technique for boosting bread wheat yields, and the yield component is commercially viable. Wheat production rises with improved field fertilization, including 91% N, 63% P, and 176% N+P2SO5 (Gebremariam *et al.,*2018).In order to achieve the appropriate soil fertility levels for crops, fertilizers are often administered to fields. It is important to note that consistent fertilizer application is necessary for crops to retain optimal yields.

Nitrogen and phosphorous are the most important components for plant growth and agricultural productivity, however most tropical soils, particularly Ethiopian soils, have low nitrogen and phosphorus availability,and the crop yields are gradually declining(Menamo, 2016). Excessive nitrogen application reduces nitrogen use efficiency in wheat and increases environmental contamination (Yang *et al*,2017).The timing of nitrogen fertilizer application is controlled by crop demand phasing and the requirement to reduce losses due to volatilization and leaching and nitrogen application is the most important fertilizer nutrient for achieving maximum wheat output (Agriculture and Sector, 2011). Nitrogen (N) is the most limiting nutrient for crop productivity in many parts of the world, and it is an essential input for cereal production systems. Sulfur is a critical ingredient for plant growth, accumulating between 0.2 and 0.5% in plant tissue on a dry matter basis. It is also necessary in a similar amount as phosphorus (Dick *et al,*2008). Crops cannot reach their full yield or protein content potential unless they have adequate S. Mony researchers discovered that frequent fertilization and other factors influence soil nutrients and crop growth, resulting in variations in crop yield and soil

nutrient content. Sulphur is becoming an important limiting nutrient to agricultural production in Ethiopian soil and the plant essential nutrients required for their growth and developments and a building block of protein, key ingredient in the formation of chlorophyll.

West Guji zone, Bule Hora District in the Oromia region is among those where the proper fertilizers have not been widely applied up to this point, most likely because of the issues mentioned above.In particular, the absence of the proper fertilizer prevents the area's potential for bread wheat from being abused. The improved yield and production status of the bread wheat production in the area are not specifically mentioned in the available information.Consequently, it became necessary to find a more productive NPS and urea fertilizer and start using inorganic fertilizers (NPS and urea) in West Guji, Bule Hora to increase agricultural yields. However, more research is needed to determine the best NPS and urea fertilizer for bread wheat in the study area.

Objectives

General Objective

- To increase bread wheat (*Triticum aestivum L.)* production and productivity in the high lands of West Guji Zone

Specific objective

- To determine combined application of NPS and N fertilizer rate for bread wheat,
- To identify the optimum fertilizer for higher grain yield with higher economic return in the high lands of West Guji, Bule Hora District.

2. LITERATURE REVIEW

2.1. General Overview of Wheat

Agriculture is at the center of Ethiopia's economy, providing a living for the vast majority of the population. According to government estimates, agriculture accounts for approximately 42% of the country's GDP, providing a living for more than 80% of its inhabitants(AD*, 2021).Wheat is one of Ethiopia's most important crops in terms of production and consumption. Wheat is the country's second most significant food, trailing only maize in terms of caloric intake per capital(FAO,2016). It is one of the world's most important agricultural products, as well as a major staple food crop. It provides 20% of global dietary energy and is an important source of protein in developing countries(Rut-Duga, 2019).Wheat is becoming increasingly popular in Sub-Saharan Africa as a result of rising incomes and rapid urbanization, but sub-Saharan countries and Africa as a whole produce only about 30% and 40% of their domestic needs, respectively, resulting in a heavy reliance on imports and making the region highly vulnerable to global market and supply shocks. The wheat economies of Africa are distinguished by a widening imbalance between wheat supply and demand.

2.1.1. Wheat production in Ethiopia

Bread wheat (*Triticum aestivum L.*) is an annual crop plants belonging to the family Poaceae (*grass family*) and native to the Mediterranean region and southwest Asia.Bread wheat (*Triticum aestivum*) is a young hexaploid species that evolved from a domesticated free-threshing tetraploid progenitor, genome BBAA, and Aegilops tauschii, the diploid donor of the D sub genome, barely 8,500-9,000 years ago. It spread rapidly from its cradle in the Fertile Crescent to new habitats and climates, eventually becoming a staple food of humans(Levy and Feldman, 2022).Smallholders dominate Ethiopian agriculture; as of 2014, about 5 million farmers produced bread and wheat in Ethiopia.

Wheat is one of the cereal crops produced extensively in Ethiopia's highlands. It is mostly produced in the Southeast, Central, and Northwest regions of the country. A limited amount is

generated in the remaining southern and northern regions. It is also one of Ethiopia's most economically important crops, accounting for 37% and 33%, respectively, followed by coffee (FAO. 2015; World Bank. 2016).Agriculture is currently the dominant sector in Ethiopia's economy, notably rain-fed and subsistence farming (Beketa, *et al*., 2020).Wheat is grown on 2.1 million hectares (1.7 million hectares under rainfed conditions and 0.4 million hectares under irrigated conditions) each year, generating 6.7 million tons of grain with an average productivity of 30.0 and 40.0 qt/ha under rainfed and irrigated conditions, respectively, in 2021/22. Furthermore, rain-fed wheat production occurs predominantly during Ethiopia's significant rainy season, which runs from June to October in the country's highlands(Haile *et al.,* 2022; Tadesse *et al.,* 2022). Wheat is also the fourth-largest cereal crop grown by about 5 million smallholder farmers, who account for roughly 35% of all small farmers in the country. It accounted for over 17% of arable land and one-fifth of all cereal food crops grown in the country in 2013/14. After South Africa, Ethiopia is Sub-Saharan Africa's second-largest wheat producer (Abera *et al*., 2021).Wheat is already widely farmed in Ethiopia, therefore the potential for further output may be limited to intensification on existing lands through the use of newer cultivars, fertilizer, and pest and disease control technologies. High-yielding, stem- and yellow-rust-resistant cultivars will prove valuable. Limited wheat growth into new commercial producing regions is also viable, particularly in locations with high market access and close to metropolitan centers.Wheat is a temperate cereal that is cultivated in a variety of precipitation and temperature conditions, primarily between 25° and 50° latitude; although, wheat production has spread into tropical and subtropical areas to less than 15° latitude. This is attributable in part to the availability of more extensively adapted semi-dwarf germplasm, as well as increased demand for wheat-based goods in these countries. Wheat is grown in tropical and subtropical locations during the cold season, frequently at high altitudes, to avoid the negative effects of high temperatures(Badaruddin *et al.,* 1999)

2.1.2. Importance of bread wheat.

Agriculture in Ethiopia contributes 34.1% of GDP, employs approximately 79% of the population, accounts for 79% of foreign earnings, and is a major source of raw materials and capital for investment and market.wheat is one of the major cereals grown in Ethiopia for use

as food and industrial raw materials(MOA, 2019).It is, in fact, the single most significant major food crop imported from outside. Bread and wheat are the most common sources of human nourishment globally, and they require extensive study to boost production and sustainability in the face of increasing food costs (Basha *et al*., 2021)**.** It is not only the world's most significant cereal crop, but also the primary source of staple food for the population (Malik *et al.*,2008 ;Mann and Jehangir, 2021) Bread wheat is also an important primary food crop in Ethiopia, particularly in urban areas, and an energetic food in many Ethiopians' diets, accounting for approximately 15% of the caloric intake for the country's over 90 million people, trailing only maize and slightly ahead of teff, sorghum, and enset, which each contribute 10-12%. Bread wheat (*Triticum aestivum* L.) is one of the most significant crop species, having contributed to the birth and development of agriculture and feeding a major portion of the world's population for millennia. It is also cultivated in almost every part of the world, providing a primary source of food and income for millions of smallholder farmers. It is an essential staple food crop (Bezabih, 2020; CSA, 2021)*,* around 85% of bread wheat is grown in Arsi, Bale and Shewa regions (Biri *et al*.,2023).

2.1.3. Problem of bred wheat production in Ethiopia

Ethiopia's economy and livelihoods rely heavily on agriculture (Gudina and Alemu,2023;BFS /USAID. 2017). The energy required for increased agricultural production without a balanced application of fertilizers caused soil fertility collapse. Mineral fertilizers have been a key tool for overcoming soil fertility issues, and they are also responsible for a significant portion of the growth in food production (Gomiero,2019). Ethiopia's agricultural sector relies heavily on soil fertility (Zelleke *et al.*, 2019). One of the most significant challenges facing Ethiopia's crop output and productivity is deteriorating soil fertility. Soil erosion, deforestation, continuous cultivation of the same land, insufficient applications of organic and inorganic fertilizers, and decreasing or abandoning effective traditional soil restoration practices are all contributing factors to declining soil fertility, which lowers wheat production and productivity (Haile *et al.,*2018). Ethiopian soil fertility has fallen and is continuing to decline, creating a challenge to wheat production and soil nutrient depletion has been studied in Ethiopia and elsewhere(Amare *et al.*, 2013;Van Beek *et al*., 2016). Low and falling soil fertility result from

continuous agriculture in which levels of soil fertility replenishment, by whatever methods, are insufficient to counteract the process of soil nutrient mining, which requires additional inputs to restore soil fertility. Intensively farmed highlands in East Africa lose an estimated 36 kg N, 5 P, and 25 kg ha-1 per year(Bekunda *et al*., 2010). Low soil fertility, improper mineral fertilizer usage, diseases, weeds, inconsistent rainfall distribution in lower altitude zones, and water logging in the Vertisol areas all have a detrimental influence on wheat output in the nation(Amanuel *et al*.,2002).Ethiopia's biggest impediment to wheat production is apparently a lack of nitrogen (N) and phosphorus (P).The primary nutritional factor influencing crop yield is typically poor soil nitrogen (N) availability (Bayeh and Birhanu *et al*., 2010),and the greatest impediment to cereal crop development in Ethiopia's highlands is the soil's normal low nitrogen content, which is essential for plants and other issues with wheat production in Ethiopia include wheat stripe rot and abiotic stressors. Wheat stripe rust is one of the most common and distracting wheat diseases seen globally(Chai Y.*et al*., 2015 ;Eagle *et al*., 2022). It is one of the most serious fungal infections in Ethiopia's key wheat-producing regions, causing a significant output bottleneck(Ayele Bedebo, 2008). Abiotic stressors are one of the challenges in wheat production that have an influence on growth and development as well as yield. Wheat rust (*Puccinia spp*.) is a disease of the wheat crop that causes 26% of output losses (Tadesse *et al*., 2010). These diseases have spread to parts of the West Guji highlands. West Guji is well-known for its humid weather, which contribute to wheat stripe rust outbreaks. Stripe rust, stem rust, and leaf rust are three rust diseases observed in the research region that cause significant issues in wheat production during study.

2.1.4. Importance of fertilizer in bread wheat production

Fertilization is an essential agronomic strategy, and the proper use of fertilizers may enhance agricultural growth and development while also improving bread and wheat quality and yields (Liu *et al*., 2021) ,and the application of fertilizer to wheat fields in Ethiopia is meeting energy. Balanced and appropriate soil nutrient management is a critical technique for enhancing bread wheat yield, yield component, and economic profitability. Furthermore, the use of varied quantities of blended (NPS) and urea fertilizer has a significant impact on all yield components of bead wheat (Sigaye *et al*.,2022). Optimal nutrients are required for

precise and balanced fertilizer recommendations, which are vital for guaranteeing food security and boosting wheat yield in a sustainable way for farmers and other stakeholders (Firomsa *et al*., 2020). Wheat's reaction to fertilizer treatment varies according on variety, rainfall, soil type, and agronomic practices. As a result, suggestions for location-specific fertilizer rates are required to boost bread wheat production(Awulachew, 2019). Nitrogen and phosphorous are the most important components for plant development and wheat production, yet most tropical soils, particularly Ethiopian soils, have low nitrogen and phosphorus availability. For these reasons, bread wheat yields are gradually dropping(Menamo, 2016).

2.2.Response of bread Wheat to Inorganic Fertilizer Application Rate

Inorganic fertilizers provide nutrients fast, allowing you to feed your plants whenever and however you choose. They are entirely synthetic and produced in exact doses. The nutrient ratios are clearly mentioned on the bag, and an organic fertilizer is available to meet your plant's specific needs. Inorganic fertilizer, which is typically affordable, is composed of mineral-based fertilizers intended for immediate application to crops. Inorganic fertilizers are made from elements such as nitrogen (N), phosphorus (P), potassium (K), and sulfur. Inorganic chemicals promote plant development by increasing the availability of essential nutrients such as ammonium sulphate and lime. Inorganic fertilizers, such as ammonium sulfate or ammonium phosphate, are frequently referred regarded as commercial or synthetic fertilizers since they are manufactured, even if many of them. Inorganic fertilizers generally include only a few nutrients, such as nitrogen, phosphorus, potassium, sulfur, and, on occasion, micronutrients, either alone or in combination. These nutrients come in a form that plants can use. Fertilizers can also be thought of as plant nourishment. Plants and crops, like humans, require appropriate and constant nutrients from the soil in order to survive. Plants require an even distribution of nitrogen, phosphorous, potassium, and sulfur. Nitrogen, phosphate, potassium, and sulfur are the four most critical nutrients for increased crop yields and long-term food production. However, because they are rapidly taken from the soil, you may need to feed plants many times during the growth season unless you choose a specially designed, slow-release kind.

2.2.1.Response of bread wheat to nitrogen (N) fertilizer rate

Wheat requires 2 to 2.5 pounds of nitrogen (N) per bushel of grain, or 1 pound per acre if grazed, or 3 pounds per acre for each animal increase. A lack of nitrogen may result in diminished tillering, smaller head size, poor grain fill, and low protein content. Nitrogen (N) accounts for around 78% of the air we breathe. Plants cannot use it since it is inert and insoluble in its current state. To make nitrogen fertilizer, nitrogen must be taken from the air and combined with hydrogen to produce ammonia. Ammonia can be applied directly to crops as a nitrogen fertilizer or used as a building block to make other nitrogen fertilizers.Nitrogen is an essential component of winter wheat production, and it is often the most yield-limiting nutrient. It stimulates tillering, photosynthesis, and grain protein production. Nitrogen availability must be carefully controlled throughout the wheat growth cycle by adjusting nitrogen fertilizer timing, rate, form, and location. Nitrogen (N) is the most limiting nutrient for crop productivity in many parts of the world, and it is one of the most important inputs in grain production. Highly soluble nitrogen (N) fertilizers, such as urea, can be lost from the soil plant system due to leaching, volatilization, and denitrification, lowering arable crop yields and NUE (Hirel *et al*., 2018). Early nitrogen treatment stimulates additional tiller development, allows for optimal yields, and promotes leaf growth and area, increasing radiation intercepted and dry matter production(Abayomi, 2016).As the number of tillers rose, so did the rate at which nitrogen (N) fertilizer was applied to the plants. Higher N treatments lead to increased tillering and a higher proportion of tiller survival (Harfe, 2017). Wheat grain and straw yields increased with nitrogen application after chickpea, grass pea, and faba bean precursor crops; plant height increased with higher nitrogen application rates for wheat; and head length was unaffected by different nitrogen rates after faba bean(Bereket Haileselassie *et al.,*2016).

Nitrogen is required for plant metabolism and is used in all plant processes. If there is inadequate nitrogen fertilizer, wheat productivity and quality deteriorate; on the other side, excessive nitrogen application reduces nitrogen consumption efficiency in wheat and increases environmental pollution (Dogan and Bilgili,2010; Liu and Shi, 2020). All crops require nitrogen (N) to form a photosynthesisally active canopy, which has a significant

impact on output. Increasing N supply to a crop results in increased canopy biomass, which has the potential to boost photosynthesis and productivity. Nitrogen application amount and cultivar: implications on wheat production and yield metrics(Bornhofen *et al.,* 2012;Noureldin *et al*., 2013). Wheat yield response to nitrogen varies according to climate, soil, and cultivar. Furthermore, in exceptionally favorable conditions, excessive nitrogen levels may not affect grain output. Wheat production, particularly in semiarid environments, is heavily impacted by nitrogen control. Using a higher amount of N resulted in significant increases in all metrics except spike duration (El-Naggar *et al.,* 2022).The yield potential and height of the variety are the most important elements in determining the appropriate nitrogen fertilizer rate in wheat; short-stemmed and high-yielding varieties are very sensitive (Agriculture and Sector, 2011).

The timing of nitrogen fertilizer application is controlled by crop demand phasing and the requirement to reduce losses due to volatilization and leaching. Most wheat types will respond to a little quantity of nitrogen fertilizer applied at sowing; however, if moderate and high rates are utilized, the primary treatment should occur at the start of the rapid growth and development stages, which range from tillering to spike development. Sometimes two or three top dressings are warranted. Nitrogen application at or shortly after ear emergence can assist increase grain protein content and enhance bread-making quality. It is crucial to note that under irrigation circumstances, it is advisable to apply nitrogen fertilizer in a split application, particularly nitrogen fertilizer, and always top-dress fertilizer only**.**Bread wheat grain yields rose with higher phosphorus fertilizer application(Yohannes, 2014; Minale,2020).The combination of N and S fertilizers boosts crop plants' net photosynthetic rate, which increases grain production(Ahmad and Abdin,2020).

The nitrogen fertilizer rate rose with plant height, as did the P fertilizer rate(Harfe and Mehoni., 2017). The increased plant height at the greatest dosage of nitrogen fertilizer might be due to the increasing availability of nitrogen, phosphorus, and sulfur nutrients(Rizk *et al.,*2012). The number of tillers at mid-tillering, spike length, plant height, and 1000 seed weight of the wheat plant were all changed knowingly by the administration of varied nitrogen and phosphate fertilizer amounts. Managing nitrogen inputs in wheat production

systems is a critical problem for achieving maximum profitability while minimizing environmental effect(Goda*, 2021)**.**The increase in the number of productive tillers generated in response to increasing N and P fertilizer rates can be linked to the plant's synergic activities in improving productive tiller production(Firehiwot, 2014).

2.2.2.Response of bread wheat to phosphorus (P) fertilizer rate

Phosphorus in fertilizer comes from phosphate rock, which is often taken from the earth's crust and then interacts with various acids to produce various phosphate compounds. Most fertilizers contain phosphorus, which helps plants thrive. Adequate phosphorus fertilizer is linked to enhanced tillering and grain head counts, decreased winter mortality, maximum water use efficiency, earlier maturity, and lower grain moisture at harvest. Next to nitrogen, phosphorus is the most critical nutrient required by wheat crops. It is essential for crop development, beginning with wheat seedlings and continuing till maturity.This vitamin promotes consistent heading, rapid maturation, and strength. The plant contributes to winter survival while also aiding with photosynthesis. Wheat requires 0.5-0.6 pounds of P2O5 (the plant's accessible form of phosphorus) per bushel. Plants suffer from shortages when there is insufficient phosphorus (P) available in the soil. Phosphorus plays an important role in plants: it stimulates root development, increases stalk and stem strength, improves flower formation and seed production, makes crop maturity more uniform and earlier, increases legume nitrogen-fixing ability, improves crop quality, and boosts plant disease resistance. Phosphorus is an essential ingredient for wheat to grow and thrive

Wheat cannot grow correctly without adequate phosphorus from the soil. The wheat crop requires phosphorus to help convert other nutrients into building blocks that may be used to create new cells and growth. Wheat, in particular, needs phosphorus to develop strong roots and shoots. It cannot develop adequately when phosphate is insufficient and may show signs of a phosphorus deficiency. Slow growth, dull yellow foliage, few flowers, and purple-tinged leaves are all signs of phosphorus shortage in wheat plants. Phosphorus (P) is required for plant growth, beginning with seedlings and continuing until maturity. Phosphorus is a key nutrient for wheat, but yield responses are often lower than those to nitrogen. Phosphorus

requirements are generally high on soils that have recently been cultivated or have a brief cropping history. It can be especially useful in low-rainfall areas. In such cases, placing phosphorus fertilizer alongside or near the seed is advantageous. In intensive agriculture, phosphorus fertilizer is widely used to meet crop demands while also maintaining soil fertility by replacing the quantity of phosphorus lost with yield.Phosphorus fertilizer can refer to any fertilizer containing phosphorus or to a fertilizer with a particularly high phosphorus concentration. The amount of phosphorus fertilizer applied per hectare is determined by the amount of nutrients required and the available fertilizer grades. So fertilizer calibration is an important factor to consider when estimating the appropriate amount of fertilizer (Agriculture and Sector, 2011).

The economic feasibility of fertilizer application is ultimately decided by the crop's potential response to further fertilizers as well as the fertilizer cost at planting. Wheat development was hindered by a shortage of critical nutrients, resulting in the maximum number of days required for blooming. The time it takes for flowers to bloom was reduced by progressive increases in p levels. The current scenario Ethiopia's Ministry of Agriculture has launched a novel compound fertilizer (NPS) combining nitrogen, phosphorous, and sulfur in the ratio of 19% N, 38% P2O5, and 7% S. With the exception of the crop's harvesting index, variable phosphorus fertilizer rates influence wheat growth and yield components. Phosphorus fertilizer rates impact yield and yield components (Hussain *et al,*2004;Ghafoor, 2019)**.** The higher phosphorus fertilizer rate resulted in significantly increased plant height, which might be ascribed to greater root system development and nutrient absorption(Shen *et al.,* 2011)**.** Phosphorous has lesser mobility than any other nutrient, and it does not stay free for long, therefore it is gradually accessible to plants. Plants lacking in phosphorus have stunted development, while wheat deficiency results in decreased tillering, reduced leaf area, greater susceptibility to diseases, and delayed maturity (Ali *et al.,*2023). The rise in total tillers with P treatment might be attributed to the function of P in developing radical and seminal roots during seedling establishment in wheat, and the number of tillers in wheat increases with increasing P application. The availability of P throughout the early season protected the plants from early stressors, and its higher absorption at higher levels resulted in an increased number of grains per spike and 1000-grain weight due to its role in grain production and development.

The NPS fertilizer boosted the root and shoot lengths of the bread wheat cultivars. The rationale is that phosphorus fertilizer promotes early root growth, whereas N and S promote fast shoot length development (Shiferaw, 2019).

2.2.3.Response of bread wheat to sulphur fertilize rate

Sulfur fertilizers. There are three forms of sulfate fertilizers. Sulfate-sulfur fertilizers include sulfur in addition to other nutrients such as nitrogen and potassium. Sulfate is easily available for agricultural production, and sulfur-sulfate fertilizers dissolve fast. The majority of sulfate-containing fertilizers fall into four categories: sulfate fertilizers, elemental sulfur fertilizers, sulfate and elemental sulfur fertilizers, and liquid sulfur fertilizers. Sulfate-containing fertilizers account for the majority of the S fertilizer applied to soils. These products have the benefit of delivering sulfur predominantly as a component of multi-nutrient fertilizers, specifically SO4-2, which is instantly available for plant absorption (Zhao *et al.,*2010). Wheat reaction to S fertilizer application was investigated at 18 locations in Arsi, East Shewa, and West Shewa, and 72% of the experimental sites showed a significant response(Assefa et al., 2021).

Sulfur (S) is essential for the production of amino acids, which are the building blocks of proteins present in all living creatures. Sulfur also adds to the unique hue of crops like onions, mustard, and radishes. While it is naturally occurring in the soil, it is not always in a form that plants can use. Sulfur (S) is an important ingredient for plant development, accumulating between 0.2 and 0.5% in plant tissue on a dry matter basis. It is also necessary in a comparable level to that of Phosphorus and sulfur deficits in crops have grown worldwide due to lower sulfur inputs to the soil system and higher sulfur outputs. This has left several crops vulnerable to yield losses (Dick *et al*, 2008).Crops cannot attain their full potential in terms of yield or protein content unless sufficient S is available, and it is essential for the production of S-containing amino acids such as cysteine, and methionine ((Zhao *et al*.,2010). Sulfur deficiency causes stunted development, decreased plant height, tillers, spikelets, and delayed maturity in plants, as well as diminished stress tolerance(Abbas *et al.,*2021)**.**Wheat yield component, grain, and straw yield all rose with P and S fertilizer treatment, and combined S and P application resulted in a much higher wheat yield than single S or P application,

indicating a synergistic interaction between these nutrients(Assefa *et al*.,2021). Plant nutrition has a significant impact on the composition of cereal grains and other crop storage organs, influencing the crop's nutritional value and processing properties, as well as the effect of sulfur availability on wheat grain yield and protein content, which has been the subject of extensive research for several years (Ra *et al*., 2020). In general, it applies adequate nutrients (N, P, K, and S) at the proper rate, and other micronutrients are necessary for wheat production. Plants, however, have restricted food absorption capability and photosynthetic efficiency when exposed to heat and drought. These stresses can also reduce organ size (leaf, tiller, and spikes) and growth period for various developmental stages (tillering, jointing, booting, heading, anthesis, and grain filling). Water stress during the grain filling period significantly reduced grain yield, which was caused by a small decrease in the number of kernels per spike and a large decrease in the mean kernel weight(Hussain *et al.,*2019).

2.2.4. Effects of NPS and Nitrogen fertilizer rate on bread wheat

2.2.4.1. Effects of NPS and Nitrogen fertilizer rate on phenological parameters of bread wheat

A wheat cultivar's phenology is determined by the seasonal timing of its life cycle, with blooming being the most important event in terms of output. The key period for wheat yield determination ranges from 20 days before to 10 days after blooming (Slafer *et al*.,2023), During this period, yield is most susceptible to biotic and abiotic stress. Wheat yields are lowered due to shorter flowering and grain filling times(kamrun *et al* 2010). Days till maturity of several wheat types under normal and severe circumstances Maturity categorization is a significant aspect when selecting a wheat variety. In certain circumstances, the maturity difference at the heading does not equal the difference in ultimate maturity. Physiological maturity is often described as when the flag leaf and spikes become yellow (Mankin *et al.,* 2023). Estimating the moment of physiological maturity may be advantageous in avoiding yield penalties caused by lodging, sprouting, hail, and other hare vet hazards, and it may also be vital under certain conditions. At physiological maturity, the crop has attained its maximum grain output, and the kernels that are no longer developing simply lose water. From that point on, the crop is liable to a growing yield penalty as a result of damage from various sources. The duration of each developmental phase is mostly determined by genotype, temperature, day length, and sowing time. Blended NPS and N supplements had little effect

on days to 50% heading, while supplemented N rates were quite significant on days to 90% physiological maturity. Increasing the quantity of supplemental N dramatically increased the number of days to 90% physiological maturity. The highest rate of N supplementation resulted in the greatest number of days needed for 90% physiological maturity, whereas no N fertilizer addition resulted in the shortest growth time for days to 90% physiological maturity (Ishete *et al.,*2019).Increasing nitrogen rates increased the amount of days it took for the wheat crop to mature (Shazma *et al*.,2016),increased nitrogen treatment greatly extended the days to physiological maturity of bread wheat (Yohannes , 2014).

2.2.4.2. Effects of NPS and Nitrogen fertilizer rate on growth parameters of bread wheat

Plant height is one of the growth characteristics that is affected by fertilizer application, increasing the application of NPS and Nitrogen rate, and increasing the plant height of wheat. NPS and urea impacts on bread wheat growth characteristics; increasing the amount of NPS and the rate of N significantly improved plant height; the maximum plant height was obtained with the highest application rate of blended NPS (Ishete *et al*., 2019).Similarly, the maximum plant height with the greatest N rate grew, whereas the shortest plant height with no N fertilizer addition declined. The increased plant height in response to higher nitrogen application rates was most likely due to nitrogen fertilizer's vital function in promoting vegetative development, resulting in a considerable rise in plant height (Abdo *et al*., 2012), the maximum plant height for durum wheat at maximum application of N and application of N and P fertilizer rates Bread wheat plant height rose, with the maximum height seen following N and P treatments (Melesse, 2017). Nitrogen and potassium fertilizers boosted wheat plant height, whereas nitrogen increased wheat vegetative growth(Tiwari, 2002; Sharma *et al*., 2006).

Tillering begins around 40 days after planting and can last up to 120 days. It is a physiological mechanism that involves the continuous subterranean branching of the primary shoot's compact node joints. Tillering provides the crop with the amount of stalks needed for optimal output. Tillering is influenced by a number of elements, including variety, light, temperature, soil humidity, spacing, and fertilizer techniques(Fernando.,2015). A tiller is a branch that emerges from the leaf axial at each unenlongated node of the main shoot or from another tiller

during vegetative development and grows independently using its own adventitious roots. The panicle number, an important factor in grain output, determines the number of tillers per plant. The greatest number of tillers at the highest NPS and N rates may be attributed to a rise in the quantity and size of developing cells, resulting in a larger number of tillers. The role of P in the formation of radicle and seminal roots during seedling establishment in wheat may explain the increased total number of tillers following NPS reduction (Jemal *et al.,*2020).Spike length is an important factor because it determines the kernel number per spike, and may vary depending on the genotype (Shi *et al*.,2017). Nitrogen fertilizer increased spike length, resulting in more nitrogen application as compared to unfertilized crops and wheat spike length rose after the use of nitrogen fertilizer(Maqsood *et al*.,2012;Teshome, 2020)

2.2.4.3.Effects of NPS and Nitrogen fertilizer rate on yield and yield components of bread wheat

The effective tiller number, or the number of tillers that generate spikes and seeds, is an important factor in wheat grain output (Naruoka *et al*.2003).Effective tillering occurs when selected tillers reach the reproductive stage, creating complex spikes at the tip that transport spikelets that grow into kernels. Wheat tillering is an important agronomic trait that controls the number of heads and spikes, hence impacting grain yield. The number of productive tillers was controlled by the N fertilizer rate, and as the N application grew, so did the number (Zhang, L.*et al.,*2020; Guo, Z.*et al*., 2018).The rate of NPS and urea fertilizer affects the effective tiller. The combination application of N and P2O5 resulted in the highest number of effective tillers and raised them by 19.2% when compared to the blanket suggestion. The increase in the number of effective tillers generated in response to increased N fertilizer application rates might be ascribed to N's involvement in improving tiller production by the plant(Ishete *et al.,* 2019).Wheat spikelet is an essential phenotypic characteristic that may be used to estimate wheat crop output(Masood, S.A. *et al.,* 2014). The quantity of spikelets, fertile florets, and grains would allow for the computation of spikelet fertility, fertile floret percentage, and grain/fertile florets to better analyze spike attributes(Guo *et al.,* 2018;Meena, H.S. *et al.,*2014). The number of spikelets, and hence the number of garin per spike, is governed by the formation of the terminal spikelet. A wheat spike is made up of several spikelets and a rachis, each with two or more florets. Only 1-3 florets can mature into fertile

florets and grains. Grain is formed under the influence of the spike, which has several lateral secondary infloreseceses.Wheat kernels are sometimes referred to as wheatberries. The plant grows from the seed. Each microscopic seed includes three different sections, which are separated during the milling process to yield flour. On a thousand kernels weight, however, there was a significant difference between the control and treatment means(Abdo *et al*.2012.

Aboveground biomass (AGB) is a common agronomic metric for determining crop growth status and estimating grain output. The traditional method of estimating aboveground biomass (AGB) relies on destructive measures (Gnyp ML., *et al*., 2014).They are not only time-consuming and labor-intensive, but also difficult to implement across broad regions.Biomass yield increased as the rate of N supplementation increased, with the highest biomass yield at maximal N supplementation and the lowest biomass yield at low or zero N supplementation. The increase in biological yield with increased N rates could be attributed to adequate nitrogen in the soil, which promotes vegetative wheat plant growth such as leaf area and leaf area index, resulting in increased light interception and thus more total dry matter production at different growth stages(Ishete *et al.,* 2019). Bread wheat biomass production grew consistently as the amount of applied NP fertilizer increased, with the maximum biomass yield occurring at the highest N/P2O5 ratio.

The NPS interaction effect has a considerable impact on bread wheat biomass production (Asmare *et al.,*2023; Markos, G. and Tana, P., 2019), The increase in above-ground dry biomass at the highest rates of NPS and N might be attributed to improved root development and greater nutrient absorption, resulting in better growth and delayed senescence of crop leaves due to the three nutrients' synergetic effect(Alemu S., 2017).A Wheat grain is described as a plant that yields a dry, edible seed. It is calculated by multiplying the number of heads per square foot by the number of seeds per head and seed weight. Farmers can use estimations of these characteristics to calculate their prospective grain production. Grain-based meals, such as those made from wheat complex carbs, which are the finest fuel for our bodies, are low in fat, high in fiber, and include vitamins, particularly the four essential vitamins. NPS and urea fertilizer had an effect on bread wheat grain yield; blended NPS fertilizer and enhanced N rates have a significant impact on grain output. However, grain

yield differed significantly between the control and treatment techniques. Rising rates of combined NPS fertilizer(Alemu Rorisa., 2017). The maximum grain production at the highest NPS and N rates might be attributed to greater root development, higher nutrient absorption, and better growth supported by the synergetic impact of the three nutrients, all of which raised yield components. Nitrogen has an impact on both vegetative and yield growth, whereas phosphorus plays an important role in metabolism and energy-producing reactions and can withstand adverse environmental conditions, resulting in increased bread and wheat grain yields as a result of nitrogen and phosphorus fertilization (Irfan, M *et al*,2018). Harvest index (HI) is the ratio of grain to total shoot dry matter and is used to assess reproductive efficiency. The harvest index is determined by interactions among genotypes (G), environment (E), and crop management (M).

Historic genetic yield improvements in wheat have been accomplished mostly via improving the harvest index. Environmental factors influencing harvest index include seasonal patterns of water supplies and severe temperatures during crop reproductive development and the harvest index rose with higher N supplementation(Wang, X. *et al.,* 2020;Prasad, P.*et al*.,2006).The increase in harvest index at the greatest rate of supplemented N might be due to more photoassimilate formation and subsequent partitioning into grains as opposed to partitioning into straw, resulting in proportionately larger grain yield than vegetative biomass output(Ishete *et al*.,2019).Wheat straw is a valuable agricultural raw resource and waste product. It has the potential to be used to produce biodegradable plastics. Because of its low cost, ease of storage, and high mm, it may reduce the production cost of biodegradable plastic while increasing its market value. The rates at which NPS and urea fertilizer are applied effect bread wheat seed output. The largest straw yields were produced by combining the highest rates of NPS and N fertilizers Straw may be obtained because to its low cost and the widespread availability of plastic created from wheat straws, which is far more efficient than plastic made from other resources(Alemu S.,2017).Wheat straw, a byproduct of wheat grain harvesting, is produced in 529 million tons throughout the world each year (Govumoni *et al*., 2013). It is one of the most plentiful renewable materials and is readily hydrolyzed(Gallezot, P., 2012).

3. MATERIALS AND METHODS

3.1. Description of Study Area

The experiment was conducted on Bule Hora District (Hera Lipitu Kebele Sub site) during 2023 cropping season (Fig.1).Geographically, it is located at $5^0$35”0 N latitude and $38^0$15”0E longitude.West Guji is one of the zones of the Oromia region of Ethiopia. Located in southern Oromia, West Guji is bordered on the south by Borena, on the west by the Gedeo Liyu Zone and on the north Sidama Region and on the east by the East Guji Zone. Its administrative center is Bule Hora. The Bule Hora Woreda has 39 kebeles, Hera Lipitu Kebele one of Bule Hora Kebele’s, which found North direction of Gerba Town. Bule Hora Town is one district of the Zones (BHWAO, 2019). the study site was recognized with an elevation of 2000 m.a.s.l having bimodal rainfall distribution pattern(Natol *et al.,* 2022). and annual mean rain fall 586.84mm; annual maximum temperature 28.08 ^{0}c and minimum temperature 8.22^{0}c.It also study site soil, Sandy loam soil type and soil pH 5.8 accordingly, soil analysis result, these ratings better for wheat production.The major field crops grown the study areas are Maize, enset, wheat and barley (Natol *et al*., 2022).

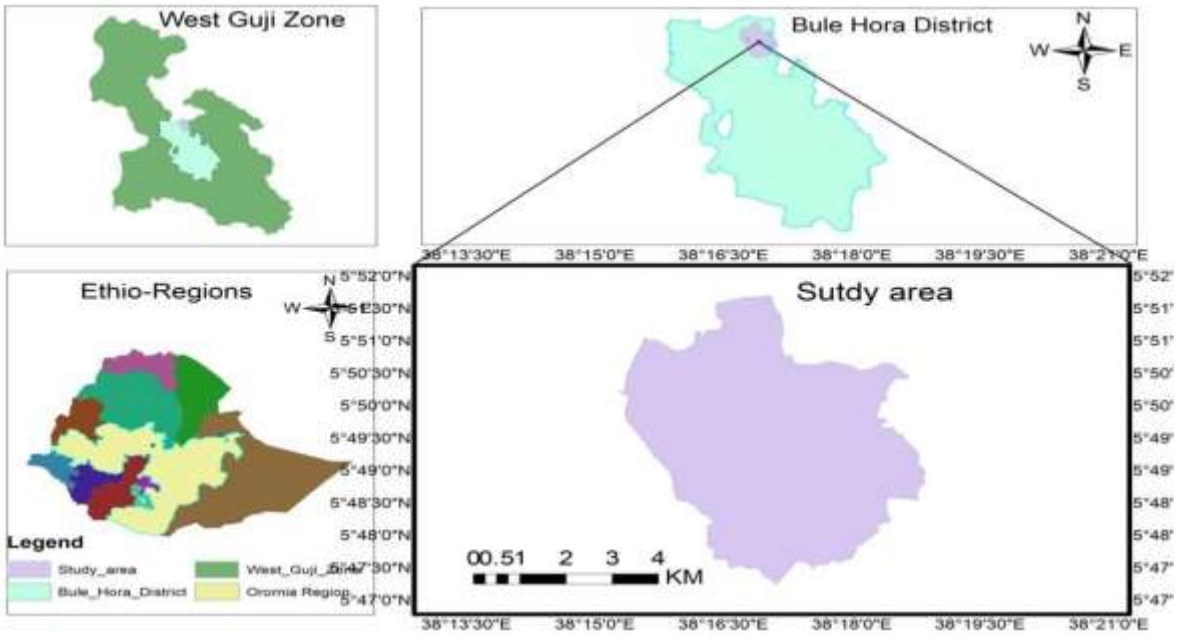


Figure 1 Map of Study area

3.1.1. Metrological data

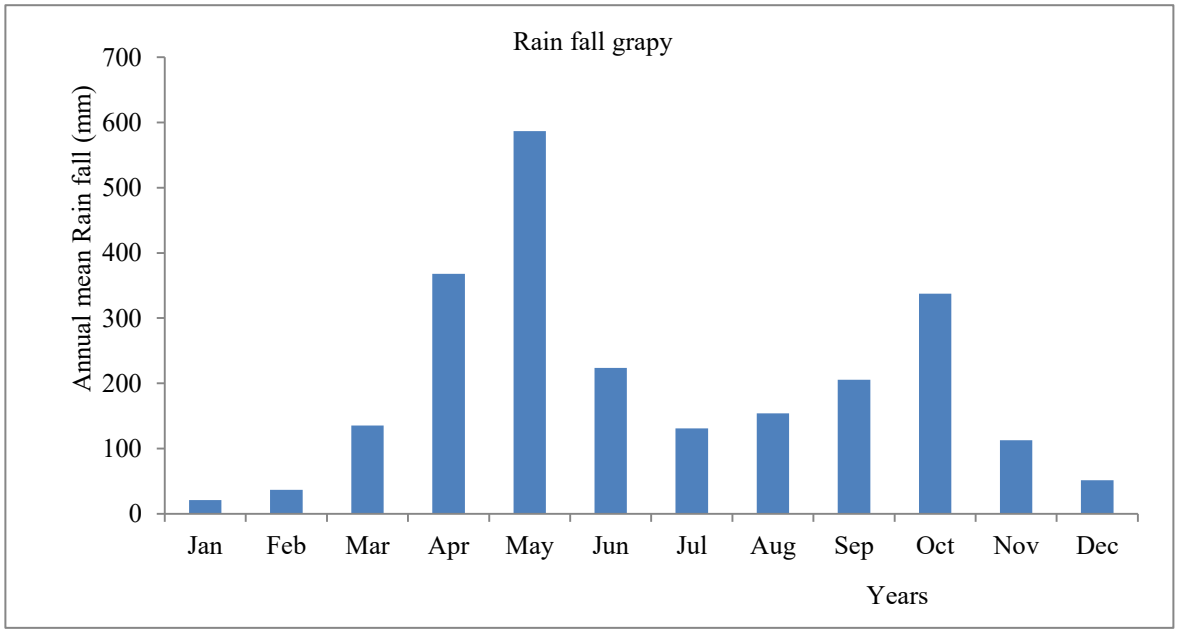


Figure 2a The Study area rain fall pattern for the last monthly (2019-2023)

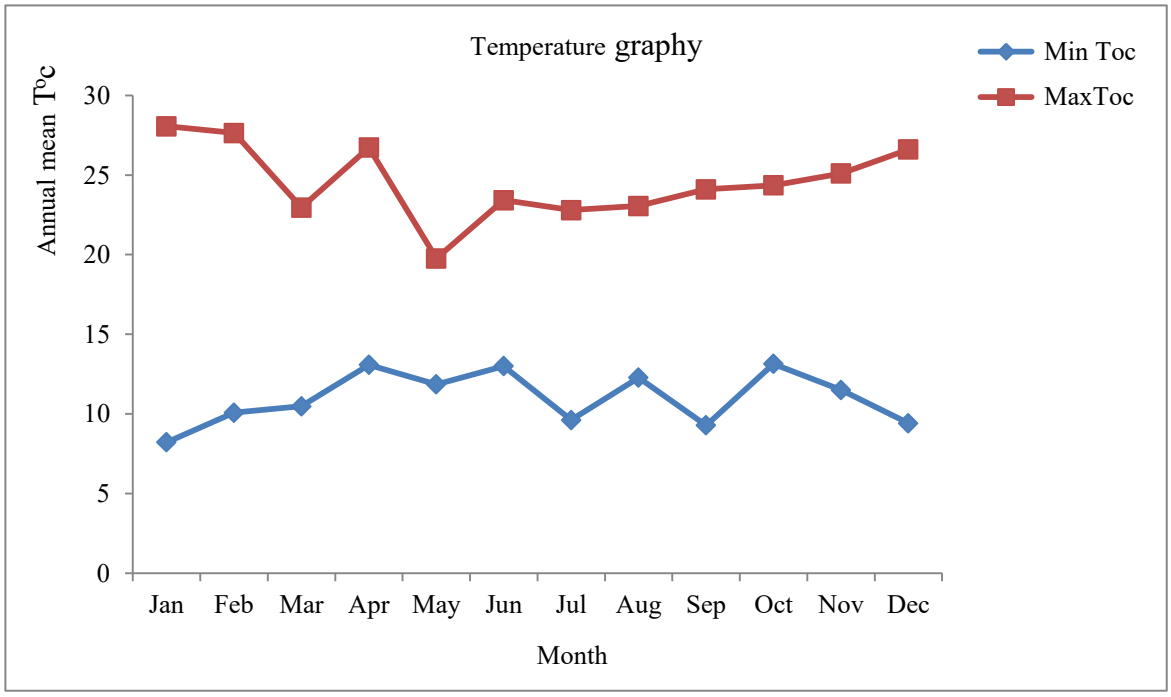


Figure 3b The Study area temperature for the last monthly (2019-2023)

Source: Ethiopia National Meteorology

3.2. Experimental Materials

One bread wheat variety: Sanate which was released by Sinana Agricultural Research Center in the year of 2012 was used for the study. This variety was selected based on yield, disease resistance, farmer's acceptance and adaptability to the agro ecology of the study area. Blended NPS (18% N, 38% P2O5, and 7% S) and Urea(N) was used as fertilizer sources.

3.3. Experimental Design and Treatments

The experiment had thirteen fertilizer treatments as a sigle factor (Table 1). The treatements were formulated using different rates of NPS and Urea(N) fertilizes as well as the fertilizer rate used by the farmwrs as a local check. The expriement was laid out in RCBD with three replications. The gross plot size was 3 meter length * 1.2-meter width =3.6 m^2 with three 6 rows.The spacing between rows, plots and blocks were 0.20 m, 0.5 m and 0.75 m respectively.

Table 1 Treatments used for the experiment

No Trt	Fertiliozer treatements	Nutrient contents		
		N	P_2O_5	S
1	Control (negative)	0	0	0
2	140kg UREA(N)	64.4	0	0
3	280kg UREA(N)	128.8	0	0
4	60 kgNPS	10.8	22.8	4.2
5	60 kgNPS + 140kg UREA(N)	75.2	22.8	4.2
6	60 kgNPS + 280kg UREA(N)	139.6	22.8	4.2
7	120kg NPS	21.6	45.6	8.4
8	120kg NPS + 140kg UREA(N)	86	45.6	8.4
9	120kg NPS + 280kg UREA(N)	150.4	45.6	8.4
10	180kg NPS	32.4	68.4	12.6
11	180kg NPS + 140kg UREA(N)	96.8	68.4	12.6
12	180kg NPS + 280kg UREA(N)	161.2	68.4	12.6
13	100kgNPS+100kgUREA(N) control (positive)	64	38	7

3.4. Experimental Procedure

The experimental field was ploughed by oxen three times and prepared before planting and a field layout was made and each treatment was assigned randomly to the experimental plots within a block. The one selected improved variety of bread wheat were sown in 31-Murch 2023 cropping season at the recommended seed rate of 125 kg ha-1 (*Natol et al*., 2022) in rows of 20 cm spacing manually by drilling method. The whole amount of NPS blended fertilizers were applied at sowing time placed near seed whereas, urea(N) was applied half at time of sowing and the remaining half at 30 days from emergence to a rapid development stage or tillering.

3.5. Soil Aampling and Analysis

Per sowing representative of composite soil sample was taken at a depth of 0-30cm randomly selected six samples of soil across experimental field by zigzag method using of auger to 1kg soil was taken. Then the collected samples was air dried at room temperature and submitted to laboratory, was ground to pass through a 2 mm sieve for the total whereas for Organic Carbon (OC) and available nitrogen (N) determination, the soil was grounded to pass through a 0.025mm sieve due to small size. This means, if increasing surface area and solubility whereas decreasing soil size. The per sowing samples was analyzed for selected physicochemical properties, such as texture, soil pH, total nitrogen, Organic Carbon (OC), available phosphorus, Organic matter (OM) Cataine exchange capacity (CEC).

Post-harvest soil samples were taken from each treatment within the experimental plot (0 to 30 cm depth) after harvesting by zigzag methods using of auger and three soil samples (0.5 kg) was taken from each experimental unit and total 39 soil sample. Then both soil sample analyses were carried out at the soil laboratory of the Yabello Pastoral and Dry land Agriculture Research Center (YPDARC) and Jimma Agricultural research center (JARC) for sulphur analysis.

Post-harvest soil samples were used for analysis after harvest: Soil pH, total nitrogen (N), available phosphorous (P), available sulfur(S), organic carbon (OC), Organic matter (OM),

and Cataine exchange capacity (CEC) were analyzed. The texture or particle size was determined by the Haydrometry method. Organic carbon was determined by the Walkely and Black oxidation method (Walkely and Black, 1934) while total nitrogen was analyzed by the Kjeldhal method (Dewis and Freitas, 1970). The pH of the soil was determined at1:2.5 water suspension (pH meter)(Page, 1982). Cation exchange capacity was measured after saturating the soil with 1N ammonium acetate (NH4OAC) and displacing it with 1N NaOAC (Chapman, 1965) and available phosphorus was determined using the Olsen method (Olsen *et al*., 1954), available S was determined using turbid metric method (Chesnin and Yien, 1951).

3.6. Data Collection

All data parameters (Phenological,Growth,Yield and Yield Componets) were done as the recommendation. Data on the Phenology, growths and yield and yield components were taken from the four central rows and eight plants randomly selected from each net plot areas of the experimental plot, then the collected data's were analysed.

3.6.1. Phenological Parameters

Days to heading**:** Days to heading was recorded as the number of days from sowing to 50% of heads Physiological maturity: physiological maturity was recorded as the number of days from sowing to when 90% of fully matured or the peduncle turned to yellow in straw color. It was recorded when no green color remained on glumes and peduncles of the plants, it means when grains are difficult to break with thumb nail.

3.6.2. Growth Parameters

Plants height: eight plants were randomly selected from the net plots area of each experimental unit. Then the height was measured from the selected plant from the ground to the tips of spike using of ruler and the mean value was determined in respective to each plot.

Spike length: Spike length was determined by taking eight effective tillers randomly from each net plot at the time harvesting and can be measured from the bottom of spike to the tip of

the spike. Then, the mean value was determined for each net plot experimental unit from the recorded data in centimeter.

Number of total tiller per plant: number of tiller total per plant was estimated by counting tillers of eight plant samples randomly from each net plot at full tillering stage of crops by counting the total number of tillers and then the mean value was determined.

3.6.3.Yield Components

Effective tiller number: number of effective tiller was determined by counting all spikes which can bear kernels from the eight plant samples randomly selected at full spike of the crop and the mean value was calculated from the recorded value.

Spikelet per spike: number of Spikelet per spike was determined by counting all Spikelet which can attach spike from the eight plant samples randomly selected at physilogica maturity of spike, the spikelet and the mean value was calculated from the recorded value.

Number of grain per spike: number of garin per spike was determined and measured by taking eight spike head randomly from each net plot area at the time of harvesting. Then the spike was threshed separately and the seeds were counted carefully for the purpose of mean number of garin per spike for each plot.

Thousand grain weight: Thousand garin weights was determined based on the weight of 1000 grain yield sample by weighting with electronic balance and adjusted to 12.5% moisture level and expressed in grams

Harvest Index: harvest index was computed as the ratio of adjusted grain yield to above ground dry biomass for each treatment in experimental plot and finally expressed in percent as:

$$HI(\%) = \frac{Grainyield}{Abovegroundbiomss} x100$$

3.6.4. Yield

Above ground dry biomass: dry biomass was measured from the plant parts harvested from the net plot area for each treatment after sun drying and corresponding to relative moisture of 86% dry weight and it's expressed in tons per hectare.

Straw yield: it was computed the difference between the total above ground dry biomass yield and grain yield for each treatment in experimental plot and finally expressed in t/ha.

SBM = above ground dry biomass - Grain yield

Grain yield: grain yield was determined for each treatment by harvesting and threshing of crops separately from the net plot area and then weighted by electronic balance. Then the grain yield was expressed by adjusting of it's to 12.5% of moisture content and finally expressed in qt/ha..

3.7. Data Analysis

All data recorded and collected were subjected to the procedure of analysis of variance (ANOVA) using of SAS version 9.3 according to the Generalized Linear Model (GLM) and interpretations were made the procedure described by Gomez (1984). The comparisons among and within treatments means were employed by using least significant difference test at 5% significant level.

3.8. Partial Budget Analysis

The economic analysis were carried out by using the methodology described in CIMMYT (1988) in which prevailing market prices for inputs at planting and for outputs at harvesting was used. All costs and benefits were calculated on ha basis in Birr. The concepts was used in the partial budget analysis are the mean grain yield of each treatment, the gross benefit (GB) ha-1 and the field price of the costs of NPS and Urea and the application costs. The benefit of straw yield(BSY) was included in the calculation of the benefit, the farmers in the area do use it.Preparation of a partial budget in order to estimate the net benefits arising from alternative treatments. For each treatment in the trial, including the control, value of production to the

farmer, including called gross field benefit (GFB), value of all inputs which differ in kind or amount used across treatments called total costs that vary (TVC).Calculation of the net benefit, the difference between gross field benefit (GFB) and total costs that vary (TVC).

Marginal analysis is used to assess relative profitability among alternative treatments. Non dominated treatments are first ranked from lowest to highest in terms of total costs that vary (TVC). The ratio of additional benefits (RAB) to additional costs (AC) between each pair of treatments is calculated. This ratio, expressed in percentage form, is called the marginal rate of return (MRR). Marginal rate of return, which refers to net income obtained by incurring a unit cost of fertilizer and its application, was calculated by dividing the net income in yield of bread wheat due to the application of each fertilizers rate. The net benefit (NB) was calculated as the difference between the gross field benefit (GFB) and the total costs that vary (TCV) using the formula:

$$GFB = GYxP$$

$$NB = (GY \times P) - TCV$$

Actual yield was adjusted downward by 10% to reflect the difference between the experimental yield and the yield farmers could expect from the same treatment. The dominance analysis procedure as described in CIMMYT (1988 was used to select potentially profitable treatments from the range that was tested. The discarded and selected treatments using this technique were referred to as dominated and nominated treatments, respectively. For each pair of ranked treatments, % marginal rate of return (MRR) was calculated using the formula:

$$MRR(\%) = \frac{ChangeinNB\ \ (NBb - NBa)}{(ChangeinTC\ \ Vb)} x100$$

Where NBa = NB with the immediate lower TCV, NBb = NB with the next higher TCV,

TCVa = the immediate lower TCV and TCVb = the next highest TCV

The % MRR between any pair of un dominated treatments is the return per unit of investment in fertilizer. To obtain an estimate of these returns, the % MRR was calculated as changes in

NB (raised benefit) divided by changes in cost (raised cost). Thus, a MRR of 100% implied a return of one Birr on every Birr spent on the given variable input.

The fertilizer cost was calculated for the cost of each fertilizer of NPS and UREA during sowing time. The cost of NPS and Urea application and the average open price of bread wheat at area market is Birr per kg in during harvesting time and economic analysis such as partial budget and marginal rate of return for wheat grain yield was valued at an average open market price of ETB 5,000 per 100 kg, Labour cost for field operation was 75 ETB per man/day. The yield was adjusted down by 10% to reflect actual production conditions to adjust to the farmers' production status (CIMMYT, 1988). The cost of NPS and Urea was ETB 3,980 and 3,850 per 100 kg with the current market price, respectively.

4. RESULTS AND DISCUSSION

4.1. Soil Physicochemical Properties

4.1.1.Pre sowing soil physico chemical analysis

The laboratory analysis results showed that the soil physicochemical properties of the experimental site are presented in Table 2. The textures of the soils in experimental site was sand, silt and clay content (72.7%, 12.7% and 14.6%), respectively, and the soil textural class of experimental site was found to be Sand loam in texture (Table 2). The soil texture or the proportions of sand silt and clay in the soil indicates the degree of weathering, aeration, nutrient and water holding capacity of the soil. The laboratory results indicated that the soil physiochemical properties of pre-sowing soil pH value was 5.8 (H2O) and moderately acid, the soil organic carbon (OC) and organic matter contents (OM) were 1.91and 3.29% low ratings, the total nitrogen (TN) of the soil was 0.16 % low ratings. The available Phosphorous (AP) was 7.8 mg/kg soil low ratings. Cation exchange capacity (CEC) was 5.6 meq/100g soils very low ratings and available Sulphur was 0.036mg/kg soil very low ratings indicated in (Table 2).

In generally, the pre sowing laboratory result was indicated that,the experimental site soil required available phosphourus accordingly the result of per sowing soil laboratory analysis. The optimum P content for most Ethiopian soil as 15 mg/ kg soil and the available phosphorous of the study area is low.So, the soils of experimental site need phosphorous fertilizer according to (Ethio SIS 2014).The available Sulphur in the soil of experimental site is very low . Thus,the soils of experimental site required Sulphur fertlizers.Other way, If the soil pH is greater than 5.5 apply elemental sulfur (S) to decrease the soil pH to 4.5(Cui, Y *et al.*,2004).

4.1.2.Post harvest soil physico chemical analayis

Soil physico chemical of post harvesting analysis result presented in (Table 2). The pH value was 6.16 (H_2O) slightly acid, Organic matter(3.01 %).According to Walkley and Black (1934) inforim that origanic matter, 2, 2-4, 4-10, 10-20 and >20; very low, low, medium,high and very high respectively.So, the soil of experimental site soil was with in the range for soil are low rating.Organic

carbon content of 1.73%.According to Melson(1961) informed that the ratings of OC content <1,1-2,2-4.2,4.2-6 and >6;very low,low,medium,high and very high accorglely the method of Walkley and Black (1934).Thus, the Organic carbon of the experimental site soil was within the range for soils that are low ratings.Total nitrogen (0.17). Accordingly,Kjeldhal method ratings of total nitrogen <0.050, 0.050-0.125, 0.125-0.225, 0.225-0.300>0.300; very low, low,medium, high and very high. So,the expremental site soil with the soil range for soils that are medium(Dewis and Freitas,1970).Available P(45.63 mg/kg) very high. According to Oslsen method, the rating of available P <5, 5-10. 10-15, 15-20 and >20 are very low,low,medium,high and very high, respectively. So, the expremental site soil with the soil range for soils that are very high (Olsen *et al*., 1954).Cation Exchange Capacity of (23.52 meq/100g) medium rating.

The ratings of cation exchange capacity > 40, 26-40 , 25-13 , 6-12 , < 6; very high, high,medium, low and very low, respectively.Thus, the expremental site soil with the soil range for soils that are medium.Available sulphur(0.042mg/kg)very low and the ratings of sulphur. In general, the soil texture of the excremental site is sand loam, based on the results of the laboratory analysis. Sand is largest particle size, allowing for more air and water to movement and loam soils are intermediate between sand and clay – both water holding capacity and fertility; the soil pH of study area moderately and slightly acid accordgly,the results of pre and post harvest soil analysis,respectively.This result supported by some finding of Horneck *et al*,(2011) informed that most crops grow best when the soil pH is between 6.0 and 8.2;Sadia *et al*, (2023) reported that most crops and fertile soils prefer pH ranges of 4 to 8;Yan *et al*, (1996)informed that optimum pH range of 4.1 to 7.4 for wheat production.So, the soil texture and soil pH of experimental site is better for wheat production and also within the range for soils that are productive.Accordigly,the laboratory analysis result,the organic matter and organic carbon of pre sowing and post harvesting analysis indicated low ratings.Soil organic carbon content in the experimental site was low ratings according to (Walkley and Black,1934; Ethiosis ,2014).The cation exchangeable capacity (CEC) value of the soil sample of pre sowing, the rating of soil indicated, the soil has low capacity to hold exchangeable cations and high capacity to hold exchangeable cations (Landon, 1991 and Jordon, 2023).

Table 2 Soil physicochemical properties of the experimental site before sowing and after harvest

Properties	Values		Ratings	
	Before	After	Before	After
Clay (%)	14.6			
Silt (%)	12.7			
Sand (%)	72.7			
Textural class	Sandy loam			
pH: (H2O)1:2:5	5.8	6.16	Moderately acid	Slightly acid
Organic Carbon (%)	1.91	1.73	low	low
Total nitrogen (%)	0.16	0.17	medium	medium
Available phosphorus (mg/kg soil)	7.8	45.63	low	Very high
Available Sulfar (mg/kg soil)	0.036	0.042	Very low	Very low
Cathane Exchange Capacity(CEC meq/100g)	5.6	23.52	Very low	medium

Source: (Olsen et al., (1954);Melson,(1961); Lordon, (1991); Tekalign *et al., (*1991); Sims, (2000); Horneck *et al.,* (2011); EthioSIS, (2014);Jordan., (2023)

The analysis of variance showed that the effects of fertilizer rate was significantly (P<0. 001) affected on the available P(Appendix1).The maximum value of organic carbon, Organic matter ,Total nitrogen ,and available sulphur (1.9, 3.46, 0.475, and 0.064) were obtained from 60 kgNPS, 180kg NPS + 280kg UREA, 140kg UREA and 120kg NPS + 280kg UREA ha-1 fertlizer rates, respectively while minmum values(1.47, 2.53 , 0.113 and 0.02) were obtained from 120kg NPS + 140kg UREA, 120kg NPS ,and 60 kgNPS + 280kg UREA fertlizer rate ha-1,respectively.The maximum pH value (6.48) was obtained from application of 60 kgNPS + 280kg UREA fertlizer rates whereas minimum value (5.56) was obtained from 60 kgNPS fertilzer rate ha-1.The maximum value of available P and cation exchange capacity (85.66 and 34.67mg/kg) attained from 180kg /140kg NPS and Urea fertlizer rates ha-1 whereas the minimum value (8.02 gm/kg) was attained from unfertilized and cation exchange capacity anttened from 280kg urea ha-1.this might be due to increase the application of NPS fertlizer rate indicate in (Table 3).

The analysis of variance of all soil physico-chemica parameters indicated that the application of NPS fertlizer rates increaseing as increased chemical properties of the soil ecept soil pH indicated in (Appendix figure 5) while the mean results of post harvest increasing by

application of NPS and Urea fertlizer rates except organic carbon and organic matter indicated in (Table 3). In general, the soil analysis results of post-harvest, different from soil result before sowing.Might be due to increased yield.This result confirm with Chemeda *et al*,(2022) reports that soil result after harvest significantly different soil results before treatment application.

Table 3 Means of Soil physicochemical properties of the experimental site after harvest

No Trt	Fertilizer treatments	pH	OC(%)	OM(%)	TN(%)	AP mg/kg	AS mg/kg	CEC meq/100 g
1	Control (negative)	6.14	1.70	2.9227	0.145	8.02f	0.02978	18.593
2	140kg UREA(N)	6.08	1.63	2.8103	0.4753	9.78ef	0.03311	22.637
3	280kg UREA(N)	6.37	1.62	3.1703	0.1573	19.78def	0.058	18.4
4	60 kgNPS	5.56	1.90	3.277	0.158	22.72def	0.05578	21.267
5	60 kgNPS + 140kg UREA(N)	6.47	1.85	3.1817	0.155	28.8cdef	0.058	23.933
6	60 kgNPS + 280kg UREA(N)	6.48	1.74	3.0013	0.146	42.13bcde	0.01867	21.133
7	120kg NPS	6.31	1.74	2.5633	0.1127	52.33acd	0.02089	25.6
8	120kg NPS + 140kg UREA(N)	6.25	1.47	2.5297	0.114	62.92ab	0.05311	24.6
9	120kg NPS + 280kg UREA(N)	6.07	1.62	2.7993	0.136	70.57ab	0.06422	28.333
10	180kg NPS	6.12	1.75	3.024	0.147	74.09ab	0.05644	22.933
11	180kg NPS + 140kg UREA(N)	6.14	1.74	3.0013	0.1457	85.66a	0.03311	34.667
12	180kg NPS + 280kg UREA(N)	6.09	1.63	3.4623	0.169	60.17acd	0.03089	29.533
13	100kgNPS+100kgUREA(N) control (positive)	6.12	1.62	3.3387	0.163	56.25acd	0.03533	14.167
	Means	6.16	1.73	3.01	0.17	45.63	0.042	23.52
	CV%	9.17	16.99	18.11	97.22	42.47	86.12	34.28
	LSD (0.05)	0.95	0.49	0.92	0.28	32.66	0.0607	13.59

Means within a column followed by the different letter are significantly different at 5% level of significance.LSD(0.05) = least significant differenced;CV= Coefficient of Variation

4.2.Phenological parameters

4.2.1.Days to 50% heading (DH)

The effects of fertilizer rates was siginificant($P<0.05$) on days of 50% heading of bread wheat(Appendix Table 2). The longest days to 50% heading (83.67days) was recorded from the unfertlizer plot whereas the shortest days of 50% heading (70.33days) was recorded from

180 kg NPS +280 kg urea(N) ha-1 (Table 4). This might be due to the Nitrogen feed as NPS fertilizer enhance the vegetative development as well as stimulate shoot growth and due minimum duration of heading days. The result in line with the finding of (Cock and Ellis, 1992) reported that sufficient nitrogen at right time results in rapid growth and heading and short duration time.The result was in agreement with Berecha *et al*,(2023)reported that an increase in the level of NPS fertilizer application significantly hastened the days to 50% heading of the wheat plants across NPS fertilizer treatments. Berecha *et al*,(2023informed the highest level of 250 kg NPS ha-1 accelerated days to heading (63.66) compared to the control (75.08).

4.1.2. Days to 90% physiological maturity (DPM)

The effects of fertilizer rate was highly significant ($P < 0.0001$) on days of 90% phsilogical maturity of bread wheat(Appendix table 2).The longest days to physiological maturity (136days) was recorded with the control plot whereas the early maturing (120days) was recorded from 180 kg NPS +280 kg urea ha-1. Increasing of NPS and Urea level enhanced the earlier anthesis and early maturity of crop over the unfertilized(Table 4).A adequate supply of phosphorus improves numerous aspects of plant physiology, including photosynthesis, blooming, seed maturity, and seed development and promotes root development and photosynthesis.Similar results with reported of (Hussain *et al*., 2009) reported that increasing rate of phosphorus enhance earlier production in wheat and ultimately early maturity of crop and also parallel with the results of Berecha *et al*,(2023) iformed that earlier days to 90% physiological maturity (119 days) were recorded from plots treated with high NPS fertilizer level (250 kg ha-1), while delayed maturity (128 days) was recorded on control treatment.

Table 4 The effects of NPS and Urea fertilizer rate on days to 50% heading and days to 90% physiological maturity of bread wheat

No trt.	Fertilizer treatments	DH 50%	DPM 90%
1	Control (negative)	83.67a	136.0a
2	140kg UREA(N)	79.33ab	128.0bc
3	280kg UREA(N)	73.67cde	121.67de
4	60 kgNPS	76.00bcd	128.67b
5	60 kgNPS + 140kg UREA(N)	75.667bcd	124.33cd
6	60 kgNPS + 280kg UREA(N)	76.67bcd	122.67de
7	120kg NPS	78.0bc	127.67bc
8	120kg NPS + 140kg UREA(N)	75.33bcd	121.00de
9	120kg NPS + 280kg UREA(N)	73.67cde	120.00e
10	180kg NPS	70.333e	123.33de
11	180kg NPS + 140kg UREA(N)	73.00de	121.33de
12	180kg NPS + 280kg UREA(N)	70.33e	120.00e
13	100kgNPS+100kgUREA(N) control (positive)	75.67bcd	125.00bcd
	Means	75.49	124.58
	CV%	3.47	2.03
	LSD(0.05)	4.45	4.26

Means within a column followed by the same letter are not significantly different at 5% level of significance LSD (0.05) = least significant differenced; CV = Coefficient of Variation

4.3. Growth parameters

4.3.1. Plant height

The effect of fertilizer rate was highly significantly different at the probability level of ($P < 0.0001$) on plant height of bread wheat(Appendix Table 3). The maximum plant height (92.21cm,90.75cm and 89.38cm) were obtained from the application of 180kg NPS+ 280kg, 60 kgNPS + 280kg UREA(N), 120kg NPS + 140kg UREA(N) Urea fertilizer rates ha-1.Whereas the minimum value(76.46cm)was obtained from unfertilized plot (Table 5).Increasing the rate of NPS + N fertilizer rates with increased plant height of bread wheat.The beneficial role of N and P in cell division and elongation as well as the root growth and dry matter content of plants. The result was parallel with the report that increasing the rate

of phosphorous fertilizer was significantly increase the plant height of bread wheat, this might be due to better development of root system and nutrient absorption.Some authors Tegegnework Gebremedhin (2019) and Muluneh and Nebyou (2016) who informed that the highest level of nitrogen applied treatments might be due to as the nitrogen fertilizer rate increased from 0 to 50 kg/ha .The plant height increased from 70.2 cm to 87.2 cm and as the P rate increased from 0 to 100 kg/ ha the plant height increased from 70.2 cm to 87.2 cm.Similarly Melesse Harfe(2017) reported that as the nitrogen fertilizer rate increased from 0 to 69 kg/ha, the plant height increased from 82.63 cm to 94.18 cm and as the P rate increased from 0 to 30 kg/ha the plant height increased from 86.41 to 90.56 cm. Other authors Bereket Haileselassie *et al*.(2016) reported that plant height and head length of wheat increased with N application rate.Abdo *et al*.(2012) who informed that increased plant height in response to increasing nitrogen application rates due to critical role in stimulating vegetative development and the resulting significant increase in plant height . Melesse (2017) who repport that application of maximum N and application of N and P fertilizer rates increased plant height of bread wheat and also the highest height of durum wheat at applications of N and P affected the mean plant height of bread wheat. Many authors Tagesse *et al*.(2018) reports that the mean plant height bread wheat was significantly affected by the application of blended NPS and nitrogen fertilizer rates. Bekalu and Arega (2016) informed that increasing the increased the mean level of nitrogen from 0 to 60 kg ha-1 plant height of bread wheat .Abera Donis *et al*.(2021) reported that plant height increased with an increased of NPS fertilizer rate supplemented by Urea.This result is reliable with the results of Khan *et al*.(1999)who found that increasing nitrogen rates increased wheat plant height.

4.3.2. Total number of tillers per plant

Number of total tiller per plant was highly significant ($P < 0.0001$) affected by the fertilizer rates(appendix table 3).The maximum number of total tiller per (5.25) was produced under application of the NPS rates of 180kg + 280kg ha-1 respectively(Table 5) whereas, the minimum numbers of total tiller per plant (1.83) recorded from unfetilized. Maximum number of total tiller per plant recorded at highest fertilizer application rate as compare to recommended and control. Brhan (2012) indicated that application of blended fertilizer significant increase wheat tillers.According to Prystupa *et al*. (2003) informed phosphorus

fertilization impact on wheat yield and its shortage has been reported as one of the main reasons for reduced number of tillers.According to Alemu (2017) who reported that"the highest number of tillers per plant of bread wheat due to the combined application of 200/200 kg NPS/N ha-1 indicating the positive role of Nitrogen for tillering.

4.3.3.Spike length

The effect of fertilizer rate was highly significant ($P < 0.0001$) affect on the spike length of bread wheat (Appendix table 3).The longest spike (9.2cm) was recorded at the application of 180kg NPS and Urea 280kg fertilizer rates ha-1 whereas the shortest spike length (5.58cm) was recorded under application unfertilized (Table 5).The result showed that increasing the rate of NPS at higher levels increased spike length might be due to adequate NPS fertilizer applications which resulted in better length of the spike.These results are in agreement with Ahmad *et al*. (2000) concluded that spike length of wheat was increased significantly with increasing of nitrogen levels.Dereje Dobocha Goda (2021) informed that the spike length was consistently increased with increasing N rates.This result is reliable with Lemi and Negash(2020) who recorded the highest spike length for Ogolcho variety at 100/100 kg ha-1 NPSZnB/Urea application. Datta and Barker(2008) reported that the Spike length of wheat increased with application of N fertilizer increase ,in which maximum spike length of 7.93 cm while un fertilized minimum spike length 4.26cm.Bereket Haileselassie *et al*.(2016) reported that head length of wheat increased with N application rate.

Table 5 The effects of NPS and Urea(N) fertilizer rate on plant height, total tiller per plant and spike length per plant of bread wheat

No.trt.	Fertilizer treatments	PH(cm)	NTP(no)	SLP(cm)
1	Control (negative)	76.46g	1.83k	5.58i
2	140kg UREA(N)	83.88f	3.21j	7.13g
3	280kg UREA(N)	86.50cdef	3.75g	7.50f
4	60 kgNPS	84.08ef	3.13j	6.58h
5	60 kgNPS + 140kg UREA(N)	87.63cd	4.0f	7.71e
6	60 kgNPS + 280kg UREA(N)	90.75ab	4.25e	8.13d
7	120kg NPS	86.88cde	3.38i	7.88 e
8	120kg NPS + 140kg UREA(N)	89.38abc	5.0b	8.50c
9	120kg NPS + 280kg UREA(N)	88.58bcd	4.71c	8.88b
10	180kg NPS	86.04def	3.63h	8.08d
11	180kg NPS + 140kg UREA(N)	88.71bcd	5.08b	9.08a
12	180kg NPS + 280kg UREA(N)	92.21a	5.25a	9.21a
13	100kgNPS+100kgUREA(N) control (positive)	88.21bcd	4.38d	8.38 c
	Means	86.87	3.96	7.89
	Cv%	2.03	2.12	1.6
	LSD(0.05)	2.97	0.14	0.21

Means within a column followed by the different letter are significantly different at 5% level of significance.LSD(0.05) = least significant differenced;CV= Coefficient of Variation

4.4.Yield Components

4.4.1. Effective tiller per plant (ETP)

Number of effective tiller was highly significantly ($P < 0.0001$) affected by the effect of fertilizer rates (Appendix table 4).The muximum number of effective tillers (5.21) was recorded at NPS 180kg with urea(N) 280kg fertilizer rate ha-1 and the statistically less (1.63) was recorded from unfertilized (Table 6). Effective tillers are the most important because of the influence in final yield. The NPS and urea(N) fertilizer rate application increasing from zero to 180/280kg ha-1 with increased effective tiller per plant from 1.63 to 5.21.This might be due to applied top-dressing of urea fertilizer at time of tillering initiations.According to Li C *et al*.(2001) inform that nitrogen fertilization in tillering stage has a significant impact on effective tiller per plant Islam *et al*.(2002);Singh *et al*.(2002)informed that nitrogen fertilization contributed in increasing tiller production up to an optimal level. Alemayehu

(2019)reported that maximum productive tiller from minimum seed rate and vice versa.Ghulam *et al*.(2011) reporteed that lower seed rate (125 kg ha-1) significantly produced maximum tillers. Wheat effective tillering is a crucial agronomic characteristic that regulates the number of heads and spikes, hence affecting grain yield (Naruoka *et al*. 2003).

4.4.2. Spikelet per spike

The effect of fertilizer rate was highly significant ($P < 0.0001$) affect on number of spikelet per spike of bread wheat (Appendix table 4).The maximum number of spikelet per spike (19.0) were recorded from both 120kg NPS + 140kg urea(N) fertilizer level ha-1 and followed by (18.96) obtained from 180kg NPS + 280kg urea(N) fertilizer levels while the minimum number of spikelet per spike (14.04) were recorded from unfertilized(Table 6). The increased of NPS and Urea(N) fertilizer rates as increase spikelet per spike.This might be due to initiated the wheat spikelet and wheat spikelet is an important phenotypic trait and to assess the grain yield of the wheat crop (Qiu *et al*., 2022)The number of spikelet, fertile floret, and grains would allow the control of the spikelet fertility, fertile florets proportion, and grain/fertile florets to more measure(Guo *et al*., 2018).

4.4.3. Number of grains per spike

The effect of fertilizer rate was highly significant ($P < 0.0001$) affect on number of grain per spike(Appendix table 4).The maximum number of grains per spike (74.67) were recorded from both 120kg NPS +140 kg urea(N) fertilizer rates ha-1 and followed by (74.46) recorded from 180kg NPS + 280kg urea(N) fertilizer rates whereas the minimum number of grains per spike (49.58) was recorded from unfertilized(Table 6).This might be due to spike length and spikelet count are crucial factors in determining the number of kernels each spike and increased number of grains per spike could be because optimum crop stand with better nutrition of NPS fertilizer. Better nutrition enhanced the source capacity to better fill of the sink.Nitrogen is the most important nutrient which affects the assimilate production and distribution and also affecting directly and indirectly the source-sink relation.This result is in line with Dinkinesh *et al*(2020) who reported that the highest(42.7) number as seed per spike for bread wheat varieties by application of 183kg NPS ha-1.According to Usman *et al*.(2020) informed that the application of 150 kg NPSB fertilizer rate ha-1 gave the highest number of

grains per spike and also other authors Maqsood *et al*. (2002) informed that application of 150 kg N ha-1 gave the maximum number of grains per spike.According to Anwar *et al*.(2016) informed that nitrogen level of 125 kg ha-1 resulted in highest number of spikes m-2 (368) and less number of spikes m-2(261) was testified in control plots. Also who reported phosphorus application maximum spikes m-2 (364) were produced by 90 kg P ha-1 while minimum spikes m-2 (261) were counted in control plots.

4.4.4.Thousand grains weight

The effect of fertilizer rate was significant (($P < 0.05$) affect on thousand grains weight of bread wheat(Appendix table 4) The maximum number of thousand grains weight (38gm) was obtained from 180kg NPS + 140kg urea(N) fertilizer rate(Table 6)while the minimum thousand grains weight (29gm) was obtained from unfertilized.This result comparable with Maqsood *et al*.(2002) who reported that increased NPS fertilizer rate it increased Thousand grains weight and confirm with Kinaci *et al*. (2000) who reported that the thousand kernels weight was increased with increase in phosphorus level.Spink *et al*. (2000) reported that delayed sowing shortens the duration of each development phase, which ultimately reduces grain filling period and lowers the grain weight.

4.4.5. Harvest index

The effect of fertilizer rate was highly siginificnt ($P<0.0001$) affect on harvest index of bread wheat(Appendix table 4).The maximum harvest index value(44.36)was obtained from180kgNPS and 140kg urea fertilizer rate followed by (39.7) was obtained from application of 180kgNPS and 280kg urea fertlizer rate ha-1,respectively whereas minimum harvest index(25.07) was obtained from 60/140(Table 6). Harvest index is an ability of a cultivar to convert the dry matter into economic yield. The higher the harvest index value, the greater the physiological potential of the crop for the converting dry matter to grain yield. This result confirm with report of Esayas (2015) who informed that N application increased as increased harvested index of winter wheat. Contrasting of this result Hussain *et al* (2004); Ghafoor(2019) who repport that Phosphorus fertilizer rates influenced yield and yield components of bread wheat, as well as all other agronomic parameters except the harvesting

index. In contrasting Alamzeb et al,(2017) reported that increased in harvest index of bread wheat was obtained with (38 %) whereas application of higher 150 and 125 kg N ha-1 the lowest harvest index (34%) was recorded from control.According to Abera *et al*,(2021)informed that harvest index of bread wheat was different from farm to farm and with application of urea and blended NPSB fertilizer rates.

Table 6 The effects of NPS and Urea(N) fertilizer rate on effective tiller per plant, spikelet per spike, number of grain per spike, thousands seed weight and hevest index of bread wheat.

No trt.	Fertilizer treatments	ETP	SPS	NGP	TSW	HI(%)
1	Control (negative)	1.63i	14.04f	49.58g	29.0f	25.42e
2	140kg UREA(N)	3.04h	15.75e	60.54f	34.0abcde	25.27e
3	280kg UREA(N)	3.63f	16.92cd	64.83e	31.0def	28.15cde
4	60 kgNPS	3.0h	16.04e	66.42de	30.8ef	29.07cde
5	60 kgNPS + 140kg UREA(N)	3.88e	16.79d	69.46c	32.5bcdef	25.07e
6	60 kgNPS + 280kg UREA(N)	4.13d	17.58bc	69.3c	31.0def	26.05de
7	120kg NPS	3.25g	17.29bcd	66.0de	35.92ab	28.43cde
8	120kg NPS + 140kg UREA(N)	4.88b	19.000	74.67a	33.67bcde	38.18b
9	120kg NPS + 280kg UREA(N)	4.63c	18.46a	71.38b	35.0abcd	38.62ab
10	180kg NPS	3.50f	17.38bcd	67.0d	31.75cdef	32.08c
11	180kg NPS + 140kg UREA(N)	5.0b	18.92a	74.08a	38.0a	44.36a
12	180kg NPS + 280kg UREA(N)	5.21a	18.96a	74.46a	35.2abc	39.75ab
13	100kgNPS+100kgUREA(N) control (positive)	4.25d	17.71b	69.71bc	32.0bcdef	31.68cd
	Means	3.84	17.26	67.49	33.0	31.7
	CV%	2.64	2.29	1.62	7.14	11.45
	LSD(0.05)	0.17	0.72	1.84	5.81	6.12

Means within a column followed by the different letter are significantly different at 5% level of significance.LSD(0.05) = least significant differenced;CV= Coefficient of Variation

4.5. Yield

4.5.1. Aboveground dry biomass

The analysis of variance showed that the effect of fertlizer rate was highly significant($P < 0.0001$) affect on above ground dry biomass of bread wheat (Appendix table 4).The maximum aboveground dry biomass yield(13.33tha-1)was obtained from the fertilizer rate of 60kgNPS + 140kg urea(N) ha-1while the minimum aboveground dry biomass yield(5.2tha-1) was obtained from unfertlized (Table 7).This might be due to the application of urea fertlizer

increased biomass production and the increase in above graund biomss with urea fertlizer rates and also might be due to sufficient nitrogen in the soil which favors vegetative wheat plant growth and more total dry matter production occurred at various growth stages. The result was in conformity with report of Ishete and Tana(2019) who reported that biomass yield of bread wheat increased with increasing applied NP fertilizer;Jasemi *et al*,(2014) informed that vegetative growth and biological yield has much dependence to consumption of chemical fertilizers.According to Tilahun Abera *et al*,(2021) informed that biomass yield increased as the rate of N increased from zero to the highest rate of application.

4.5.2.Grain yield

The effect of fertilizer rate was highly significant($P < 0.0001$) affect on grain yield of bread wheat (Appendix table 4).The maximum grain yields value (44.33 qtha-1)were obtained from the application of 180kg NPS + 280kg urea(N) fertilizer rates ha-1 and followed (43qt ha-1)were obtained from 180kg NPS + urea(N) 140kg fertilizer rates ha-1 whereas the minimum grain yields value (13.41) were obtanied from unfertilized(Table 7).The grain yield from the treated treatemnet was higher by 8qt ha-1 local practices **,**respectively. This might be due to the effective tiller number is defined as the number of tillers that generate spikes and grain per spike as well as other critical components of wheat grain and development of effective tiller, grain per spike,pikelet per pike and length of spike were increased as application of NPS and urea fertlizers.This result is similar with the report of Ishete *et al*,(2019) reported that increased the application of NPS and urea(N) fertlizer rates as increased grain production of bread wheat.The other outhers repport Tilahun and Tamado(2019) who reported that the highest grain yield was obtained by maximum application of (200 kg NPS ha-1) and (92 kg N ha-1) for durum wheat; Mohammed *et al*,(2013) informed that at higher N application rates and top-dressing of N fertilizer significantly increased grain yield, improved grain protein content, and grain N uptake; Bizuwork.

Tafes (2018) stated that, the maximum grain yield of bread wheat was recorded at the highest application of blended fertilizer rate.This finding is reliable with the results of Tilahun Abera *et al*.(2019) who found that increasing grain yield of bread wheat was documented at the

highest application of blended fertilizer rate.The highest grain yield at the highest NPS and urea rates might have caused from enhanced root growth and increased uptake of nutrients and better growth favorite due to synergetic consequence of the three nutrients which improved yield components and yield.The balanced plant nutrition is one of the most important factors that increase crop production. Balanced supplementation of NPS nutrition is one of the greatest production inputs for crops in high land and low land areas. Maximum grain yield might be attributed to the improvement in number of productive tillers, spike length, kernels per sipke and thousand kernels weight. It could also due to, top-dressing of N fertilizer applied at time of tillering initiations where bread wheat needs in high amount N (60-70%) at this stage for grain production significantly increased grain yield. The application of fertilize rate affects bread wheat grain yield Alemu Rorisa(2017) ; Abera Donis *et al*.(2021) informed that the highest grain yield at the highest NPS rates might have caused from improved root growth and increased uptake of nutrients and better growth which enhanced yield components and yield of crops.This result conflicting with Terfa *et al*, (2023) reported that the highest grain yield (8.6 t ha−1) obtained by application of 300 kg ha−1 NPSZnB was smaller than the 9.6 t ha−1 grain yield of the same variety obtained from on farm trial with application of 100 kg ha−1 NPS. Fertilizers are applied to fields to attain desired soil fertility levels for crops grown emphasized the importance of uniform fertilizer application for crops to maintain optimum yields.

4.5.3. Straw yield

The effect of fertilizer rate was highly significant($P<0.001$)) affect on straw yield of bread wheat (Appendix Table 4).The maximum straw yields(10.03tha-1)were obtained from 60kg NPS + urea(N) 140kg ha-1 fertilizer rates whereas the lowest straw yields(3.98t/ha) were recorded from unfertilized treatement of both NPS + urea(N) fertlizer rates(Table 7). This might be due to balanced supplied of NPS nutrients lead to more vegetative growth and more dry matter accumulation which directly related to an increment in straw yield. Sopported this result Bereket *et al*,(2014) reported that wheat straw yield increased with application of N rates. Other founding Tilahun *et al*,(2017) reported that the application of nitrogen fertlizer obtained higher production of straw yield

Table 7 The effect of NPS and Urea(N) fertilizer rate on above graound biomass , straw yield and grain yield of bread wheat.

No trt.	Fertilizer treatments	AGB(t/ha)	SY(t/ha)	GY(qt/ha)
1	Control (negative)	5.32d	3.98f	13.42g
2	140kg UREA(N)	11.81abc	8.84abc	29.67 f
3	280kg UREA(N)	12.02ab	8.68abc	33.50 de
4	60 kgNPS	11.11abc	7.94abcd	31.67 ef
5	60 kgNPS + 140kg UREA(N)	13.33a	10.02a	33.00e
6	60 kgNPS + 280kg UREA(N)	13.03a	9.66ab	33.67de
7	120kg NPS	11.19abc	8.03abcd	31.67ef
8	120kg NPS + 140kg UREA(N)	9.92 b	6.15de	37.67bc
9	120kg NPS + 280kg UREA(N)	10.23b	6.33de	39.50b
10	180kg NPS	10.23b	7.03cde	32.33ef
11	180kg NPS + 140kg UREA(N)	9.72c	5.42ef	43.00a
12	180kg NPS + 280kg UREA(N)	11.22 abc	6.79cde	44.33a
13	100kgNPS+100kgUREA(N) control (positive)	11.44 abc	7.8bcd	36.33cd
	Means	10.82	7.43	33.83
	CV%	12.03	17.07	6.87

Means within a column followed by the different letter are significantly different at 5% level of significance.LSD(0.05) = least significant differenced;CV= Coefficient of Variation

4.6. Partial Budget Analysis

As indicated in (Table 8) the partial budget analysis showed that the maximum grain yield obtained with application of rate of 120NPS +140kg Urea(N)ha-1 indicated the better grain yield benefit (33.90 qtha-1) with net benefit of (213,489.73ETB ha-1)and MRR of (121479.6 %). However, the lowest net benefit was obtained from unfertilized or control plot. Thus, applications of 120 kg ha-1 NPS of blended plus 140 kg ha-1 of urea(N) is economically advisable for farmers in the study area for better bread wheat yield with high economic (beneficial) as compared to the other treatments in the study area because the highest net benefit and the marginal rate of return were above the minimum level (100%).According to (Sapkota *et al*.,2020) who repoted that the application of 50-185 kg N ha-1 fertilizer rate for in wheat provide the most economical returns and application rates beyond these ranges would be both economically and environmentally unsustainable.

Table 8 Summary of economic analysis

S.L. Trt	Fertilizer treatments	TVC (ETB)ha-^{1}	AGY Kgha-1	Price(ETB)	GBKgha-^{1}	NB(ETB)ha-^{1}	MRR%
T1	0 Nigative control	0.00	1206.9	62	74827.8	74827.80	0
T2	140Urea(N)	11068.56	2669.4	62	176718.6	165650.04	1496.58
T3	280Urea(N)	13456.56	3014.1	62	202721.4	189264.84	988.89
T4	60NPS	15844.56	2850.3	62	220410	204565.44	640.73
T5	60NPS+140Urea(N)	22751.11	2970	62	165502.8	142751.69	D
T6	60NPS+280Urea(N)	28141.11	3030.3	62	186874.2	158733.09	296.50
T7	120NPS	33819.67	2850.3	62	184140	150320.33	D
T8	120NPS+140Urea(N)	33871.67	3390.3	62	247361.4	213489.73	121479.6
T9	120NPS+280Urea(N)	36207.67	3555	62	176718.6	140510.93	D
T10	180NPS	38595.67	2909.7	62	180401.4	141805.73	54.22
T11	180NPS+140Urea(N)	39209.67	3870	62	187878.6	148668.93	1117.79
T12	180NPS+280Urea(N)	41597.67	3989.7	62	210198.6	168600.93	834.67
T13	100NPS+100Urea(N) +ve control	43985.67	3269.7	62	239940	195954.33	1145.45

ETB=Ethiopia birr,MRR= marginal rate of return,GB=Gross benefit,NB=Net benefit, TVC=total of cos of vary cost. D = Dominated and Price of NPSand urea 39.8 and 38.5 EB kg-^{1} grain price = 62 EB kg-^{1} .AGY=average grain yield

5. SUMMARY AND CONCLUSION

Bread wheat is one of the key food crops in the study area.The productivity and yield is mostly controlled by soil fertility and lack of better fertilizer rate.The study was conducted at Bule Hora District,southern Ethiopia,the main cropping season 2023 and aimed to determine the inorganic fertilizer rate for bread wheat (*Triticum aestivum* L.) production and to identify the optimum fertilizer treatments for higher grain yield with higher economic return.The all data on phenology,growth parameters and yield and yield componets were collected and analyised and identified mean separation by least siginificant different and the analysised data was interpirated.The pre and post harevest soil sampling were analyised and interpreted the results.The paritial budget analysis were done depened on variable cost and gross benfit. The net benefit and mariginal rate of returen were identified and reccommeded better fertilizer rate with higher economic return for farmers to increase bread wheat in the study area.

Finally,the analysis results showed significant affects on all parameters , with the fertilizer rate significant affect date of 90 % physiological maturity,plant height, effective tiller per plant, spike length, spikelet per spike,grain per spike, grain yield,harvest index, 1000 seed weight,above-ground biomass, and straw yields.A significantly higher (44.33 qt ha-1) grain yield of bread wheat was obtained with the application of 180 kg NPS + 280kg urea(N) ha^{-1} and 43.00 qt ha^{-1} following by application of 180/140kg NPS/urea(N) but, not an acceptable economic benefit.Therefore, on the basis of the result of the present study, it is indicative that better economic yield benefit obtained at Bule Hora and farmers can benefit more by application of 120 NPS/140 urea (N) ha^{-1} obtained higher grain yield with higher economic returen,which is economically achievable and recommended for better bread wheat production in the sand loam soil of Bule Hora District and similar agro-ecological conditions.

6. REFERENCES

Abayomi, Y.A., 2016.Effects of Inorganic Fertilizer Application on Plant Growth and Dry Matter Yield of Physic Nut (*Jatropha Curcas L.*) Effects of Inorganic Fertilizer Application on Plant Growth and Dry Matter Yield of Physic Nut (*Jatropha Curcas L.*), (April). doi:10.24102/ijafr.v5i1.587.

Abbas, S., Javed, M.T., Ali, Q., Azeem, M. and Ali, S., 2021. Nutrient deficiency stress and relation with plant growth and development. In Engineering tolerance in crop plants against abiotic stress (pp. 239-262). CRC Press.

Abdo W, Geremew B, Assefa T., 2012. Effect of different nitrogen fertilizer rates on yield and yield related traits for seven durum wheat (*Triticum turgidum L. Var Durum*) cultivars grown at Sinana, South Eastern Ethiopia. African Journal of Food, Agriculture, Nutrition and Development 12(3):6079-6094.

Abdullaeva, Y., Ratering, S., Rosado-Porto, D., Manirajan, B.A., Glatt, A., Schnell, S. and Cardinale, M., 2024. Domestication caused taxonomical and functional shifts in the wheat rhizosphere microbiota, and weakened the natural bacterial biocontrol against fungal pathogens. Microbiological Research, p.127601

Abera Donis, Dejene Getahun, Tadele Geremu, Dereje Girma, Abreham Feyisa, Lello Dejene, Meron Tolosa. 2021.Determination of NPS Fertilizer Rate Based on Calibrated Phosphorus for Yield of Bread Wheat in Wachale District, North Shewa Zone, Oromia, Ethiopia. American Journal of Plant Biology. Vol. 6, No. 3, , pp. 73-77. doi: 10.11648/j.ajpb.20210603.15

Abera, D., Tana, T. and Dessalegn, T., 2020. Effects of blended NPSB fertilizer rates on yield and grain quality of durum wheat (*Triticum turgidum L.*) varieties in Minijar Shenkora District, Central Ethiopia. Ethiopian Journal of Agricultural Sciences, 30(3), pp.57-76.

Abera, T. and Adinew, A., 2020. Effect of blended NPS fertilizer supplemented with nitrogen on yield components and yield of maize (*Zea mays L.)* in Kachabirra district, Kembata Tambaro zone, southern Ethiopia. International Journal of Research in Agricultural Sciences, 7(3), pp.2348-3997.

Abera, T., Lemma, A., Hundesa, C. and Husen, A.,2021.Response of Yield Components and Yield of Bread Wheat (*Triticum aestivum L.*) to Blended NPS and N fertilizers Levels at Liban Chukala District, East, 8(1), pp. 1–9.

Abera, T., Tola, B., Tufa, T. and Adugna, A. 2021.Effects of Blended (NPSB) and Urea Fertilizer Rate on Yield and Yield Components of Wheat in Ultisols of Liben Jawi District , Oromia , Ethiopia, (August). doi:10.5829/idosi.aejaes.2021.87.97.

Abera, Y. and Kassa, S., 2017. Status of soil micronutrients in Ethiopian soils: a review. Journal of environment and earth science, 7(4), pp.85-90

Aboye, A.D. and Teto, A.M., 2022. Pilot review study on current research status and economic value limitations of bread wheat (*Triticum aestivum L.)* Production in Ethiopia. Economics, 11(4), pp.137-166.

AD*, A., 2021.Review Study on Current Bread Wheat (*Triticum aestivum L.)* Production Status and Key Challenges for Potential Efficiency of Wheat Markets in Ethiopia pp. 1–22. doi: 10.23880/jenr-16000233

Agriculture, M.O.F. and Sector, N.R., 2011. Ministry Of Agriculture Natural Resource Sector Irrigation Agronomy Guideline.

Ahmed, S., Adat, S., Murrells, A., Owen, C.P. and Amanuel, Y., 2002. Design, synthesis, and evaluation of 4-(4′-aminobenzyl)-2-oxazolidinones as novel inhibitors of the cytochrome P-450 enzyme aromatase. Bioorganic chemistry, 30(5), pp.315-331.

Akhmad Zubaidi, G.G. and G.K.M., 2015.Adaptation of Wheat To A Tropical,"

Alamzeb, M., S. Anwar, A. Iqbal, B. Parmar and M. Iqbal, 2017. Organic sources, nitrogen and tillage systems improve wheat productivity and profitability under semiarid climates. Journal of Pharmacognosy and Phytochemistry, SP1: 73-78.

Alemu, S., 2017. Effect of blended NPS and N fertilizer rates on yield components, yield and grain protein content of bread wheat (*Triticum aestivum L*.) in Bore district, Guji Zone, Southern Ethiopia (Doctoral dissertation, MSc Thesis. School of Plant Sciences, Haramaya University, Ethiopia).

Ali, S., Riaz, A., Mamtaz, S. and Haider, H., 2023. Nutrients and Crop Production. Current Research in Agriculture and Farming, 4(2), pp.1-15.

Amare, T., Terefe, A., Selassie, Y.G., Yitaferu, B., Wolfgramm, B. and Hurni, H., 2013. Soil properties and crop yields along the terraces and toposequece of Anjeni Watershed, Central Highlands of Ethiopia. Journal of Agricultural Science, 5(2), p.134.

Anteneh, A. and Asrat, D., 2020. Wheat production and marketing in Ethiopia: Review study. *Cogent Food & Agriculture*, *6*(1), p.1778893.

Anwar, S., Iqbal, B. and Khan, S. 2016.Nitrogen and phosphorus fertilization of improved varieties for enhancing yield and yield components of wheat,(August). doi:10.19045/bspab.2016.50091.

Arega, G. and Setu, B., 2014. Prevalence, Incidence and Severity of Wheat Rust, an Response of Wheat Cultivars to Rust Infection. *International Journal of Agronomy and Plant Production*, *5*(1), pp.13-19.

Aryal, J.P., Sapkota, T.B., Khurana, R., Khatri-Chhetri, A., Rahut, D.B. and Jat, M.L., 2020. Climate change and agriculture in South Asia: Adaptation options in smallholder production systems. Environment, Development and Sustainability, 22(6), pp.5045-5075.

Aryal, J.P., Sapkota, T.B., Khurana, R., Khatri-Chhetri, A., Rahut, D.B. and Jat, M.L., 2020. Climate change and agriculture in South Asia: Adaptation options in smallholder production systems. Environment, Development and Sustainability, 22(6), pp.5045-5075.

Asmare, H.A., Berecha, K. and Chala, G., 2023. Response of Bread Wheat (*Triticum Aestivum L.*) Varieties To Nps Fertilizer Levels In Wolmera District, Ethiopia. International Journal of Agricultural and Natural Sciences, 16(3), pp.255-271.

Asrat, D. and Anteneh, A., 2020. Status of food insecurity in dryland areas of Ethiopia: A review. *Cogent Food & Agriculture*, *6*(1), p.1853868.

Assefa W, Yemane N, Dawit H.,2015b. Planting Density, and Nitrogen and Phosphorus Fertilization Effect on Different Bread Wheat (*Triticum aestivum L.)* Genotypes in Southern Tigray, Ethiopia. Journal of World Science Research 3(2):20-28.

Assefa, A., 2017.Response of Bread Wheat (*Triticum aestivum L*.) Varieties to Different Seeding Rate for Growth, Yield and Yield Components in Kombolcha District, North-Eastern Ethiopia,7(23), pp. 79–91.

Assefa, S., Haile, W. and Tena, W. 2021.Response of bread wheat to sulfur and phosphorus fertilizers in the north central, Agriculture & Food Security, pp. 1–10. doi:10.1186/s40066-021-00303-y.

Awash, M. 2019.Evaluation of Bread Wheat (*Triticum aestivum L* .) Genotypes for Yield Advances in Crop Science and Technology Evaluation of Bread Wheat (Triticum aestivum L .) Genotypes for Yield Potential and Related Traits Under High Temperature Stress Condition at Middle Awash , Ethiopia, (March). doi: 10.4172/2329-8863. 1000410.

B.L. and M.B., 2018.Effect of Nitrogen Fertilizer Levels on Grain Yield and Quality of Malt Barley (*Hordeum Vulgare L.)* Varieties at Wolmera District, Central Highland of Ethiopia,4(4), pp. 29–43.

Badaruddin, M., Reynolds, M.P. and Ageeb, O.A., 1999. Wheat management in warm environments: effect of organic and inorganic fertilizers, irrigation frequency, and mulching. Agronomy journal, 91(6), pp.975-983.

Bakala, N., Jibat, I. and Idao, B. 2022.Agro-Morphological Evaluation of Improved Bread Wheat (*Triticum aestivum L*) Varieties for Highland Areas of Western Guji , Southern Oromia 9515(1), pp. 5–10. doi: 10.36347/sajb.2022.v10i01.002.

Basha Kebede1*, G.A. and D.K., 2021.Popularization of Sanate Bread Wheat Variety in the Highlands of Guji Zone, Southern Oromia, Ethiopia(3), pp. 25–30.

Beddow, J.M., Pardey, P.G., Chai, Y., Hurley, T.M., Kriticos, D.J., Braun, H.J., Park, R.F., Cuddy, W.S. and Yonow, T., 2015. Research investment implications of shifts in the global geography of wheat stripe rust. Nature Plants, 1(10), pp.1-5.

Bekalu, A. and A. Arega, 2016. Effect of the Time and Rate of N-Fertilizer Application on Growth and Yield of Wheat (*Triticum aestivum L.)* at Gamo-gofa Zone, Southern Ethiopia. Journal of Natural Sciences Research, 6(11): 111-122.

Beketa, H.J., Kefale, D. and Yoseph, T., 2020. Effect of Blended Fertilizer Types and Rates on Growth, Yield and Yield Components of Bread Wheat (*Triticum aestivum L*.) in Wondo District, Southern Ethiopia. *International Journal of Agriculture Innovations and Research*, *8*(4), pp.326-342.

Bekunda, M., Sanginga, N. and Woomer, P.L., 2010. Restoring soil fertility in sub-Sahara Africa. Advances in agronomy, 108, pp.183-236.

Bellete, T. 2015., Soil Fertility Mapping and Fertilizer Recommendation in Ethiopia : Update of EthioSIS project and status of fertilizer blending plants Tegbaru Bellete,(November).

Berecha, K., Ashagre, H. and Chala, G.2023.Response Of Bread Wheat (*Triticum Aestivum L* .) Varieties To NPS Fertilizer Levels In Wolmera District , Ethiopia, 16(3), Pp. 255–271. Doi:10.5281/Zenodo.10204225.

Bereket H, Dawit H, Mehretab H, Gebremedhin G., 2014. Effects of Mineral Nitrogen and Phosphorus Fertilizers on Yield and Nutrient Utilization of Bread Wheat (*Tritcum*

aestivum) on the Sandy Soils of Hawzen District, Northern Ethiopia. Agriculture, Forestry and Fisheries 3(3):189-198.

Berhanu Sime, Gudeta Nepir, Bedada Girma, Alemu Dabi 2022.Genotype x Environment Interaction and Yield Stability of Bread Wheat Genotypes in Oromia, Ethiopia. American Journal of Life Sciences. Vol. 10, No. 4, pp. 72-77. doi: 10.11648/j.ajls.20221004.13

BFS/USAID., 2017.Climate-Smart Agriculture in Ethiopia. CSA Country Profiles for Africa Series. International Center for Tropical Agriculture (CIAT); Bureau for Food Security, United States Agency for International Development (BFS/USAID), Washington, D.C. 26

Biri, A., Tadesse, F., Mengistu, G., Meleta, T., Bogale, M., Balcha, U. and 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), pp.403-413.

Bizuwork Tafes. 2018. Growth, Yield and Grain Quality of Durum Wheat (*Triticum turgidum L. var. durum*) as Influenced by Rates of Blended NPSB and N Fertilizers at Debre Zeit, Central Ethiopia. MSc Thesis, Haramaya University.

Bray R.H. and Kurtz, L.T., 1945. Determination of total, organic, and available forms of phosphorus in soils. Soil science, 59(1), pp.39-46.

Brzegen, A. and Http://hdl.handle.net/123 (2019) 'GROWTH AND YIELD RESPONSES OF BREAD WHEAT (Triticum aestivum L .) TO SEEDING AND NPS RATES IN BORENA DISTRICT , SOUTH WOLLO ADMINISTRATIVE ZONE , ETHIOPIA'.

Brzegen, A., 2019.Growth And Yield Responses Of Bread Wheat (*Triticum Aestivum L .)* To Seeding and Nps Rates In Borena District, South Wollo Administrative Zone, Ethiopia.

Calura, J.G., Badayos, R.B., Villanueva-Peyraube, J.D. and Labios, J.D., 2023. A Soil Analysis Approach to Assessing Potential Loss of Productive Lands Under Agricultural Land Conversion. Asian Journal of Agriculture and Development, 20(2), pp.83-102.

Chaparro., J.M., Sheflin, A.M., Manter, D.K. and Vivanco, J.M., 2012. Manipulating the soil microbiome to increase soil health and plant fertility. Biology and Fertility of Soils, 48, pp.489-499.),

Chapman, H.D., 1965. Cation-exchange capacity. Methods of soil analysis: Part 2 Chemical and microbiological properties, 9, pp.891-901.

Chimdesa, O., Aseffa, K. and Alemu, S., 2018.Participatory Variety Selection of Improved Bread Wheat Varieties for Moisture Stress Areas of Guji Zone, Southern Oromia,5(4), pp. 1–6.

CIMMYT Economics Program, 1988. From agronomic data to farmer recommendations: an economics training manual (No. 27).

Cui, Y., Dong, Y., Li, H. and Wang, Q., 2004. Effect of elemental sulphur on solubility of soil heavy metals and their uptake by maize. Environment International, *30*(3), pp.323-328.

Dagne C., 2016. Blended Fertilizers Effects on Maize Yield and Yield Components of Western Oromia, Ethiopia. Agriculture, Forestry and Fisheries 5(5): 151-162.

Das, D.K. and Mandal, M., 2015. Advanced technology of fertilizer uses for crop production. Fertilizer Technology I Synthesıs. Sinha, S., Pant, KK, Bajpai, S.(Eds.). Studium Press, LLC, USA, pp.101-150.

Değirmenci, F.Ö., Ulaş, B., Kansu, Ç., Uluğ, A., Caneva, I., Asal, R. and Kaya, Z., 2023. The ancient DNA and archaeobotanical analysis suggest cultivation of *Triticum aestivum subsp*. spelta at Yumuktepe and Yenikapı Pottery Neolithic sites in Turkey. Genetic Resources and Crop Evolution, 70(2), pp.657-676.

Demisew Amare 1, *Wassu Mohammed, A.K., 2020.Effect of Blended NPS Fertilizer and Varieties on Seed Quality, of Bread Wheat Effect of Blended NPS Fertilizer and Varieties on Seed Quality, of Bread Wheat (*Triticum aestivum L.)* Haramaya, Eastern Ethiopia, (June). doi:10.7176/JNSR/10-7-02.

Desta, B.T. and Almayehu, Y., 2020. Optimizing blended (NPSB) and N fertilizer rates for the productivity of Durum wheat (*Triticum turgidum L.var. durum*) in Central Highlands of Ethiopia. Cogent Food & Agriculture, 6(1), p.1766733.

Dewis, J. and Freitas, F., 1970. Physical and chemical methods of soil and water analysis.

Di Lorenzo, E., Cobb, K.M., Furtado, J.C., Schneider, N., Anderson, B.T., Bracco, A., Alexander, M.A. and Vimont, D.J., 2010. Central Pacific El Niño and decadal climate change in the North Pacific ocean. Nature Geoscience, 3(11), pp.762-765.

Dick W.A., Kost, D. and Chen, L., 2008. Availability of sulfur to crops from soil and other sources. Sulfur: A missing link between soils, crops, and nutrition, 50, pp.59-82.

Dinkinesh Abera, Tamado Tana and Tadesse Dessalegn, 2020. Effects of Blended NPSB Fertilizer Rates on Yield and Grain Quality

Diriba Shiferaw, G., Rut-Duga, D. and Wogayehu, W., 2019. Effects of blended fertilizer rates on bread wheat (*Triticum aestivum L.)* varieties on growth and yield attributes. *J Ecol & Nat Resour*, *3*(3), pp.1-13.

Dobermann, A. and Fairhurst, T. 2000. Nutrient disorder and nutrient management. Handbook Series. Potash and Phosphate Institute of Canada and International Rice Research Institute. 191p

Duan, Y., Xu, M., Gao, S., Yang, X., Huang, S., Liu, H. and Wang, B., 2014. Nitrogen use efficiency in a wheat–corn cropping system from 15 years of manure and fertilizer applications. Field Crops Research, 157, pp.47-56.

Duga, R. and Worku, W. (2019) 'Effects of Blended Fertilizer Rates on Bread Wheat (*Triticum Aestivum L* .) Varieties on Growth and Yield Attributes', (September). doi: 10.23880/jenr-16000170.

Duressa, L.A. and Ayana, N.G., 2020. Effects of variety and fertilizer rate on yield of Bread Wheat (*Triticum aestivum L.)* Varieties in East Wollega Zone, Western Ethiopia. J. Agric. Biol. Sci, 6, pp.60-71.

Durfee, T., Nelson, R., Baldwin, S., Plunkett III, G., Burland, V., Mau, B., Petrosino, J.F., Qin, X., Muzny, D.M., Ayele, M. and Gibbs, R.A., 2008. The complete genome sequence of Escherichia coli DH10B: insights into the biology of a laboratory workhorse. Journal of bacteriology, 190(7), pp.2597-2606.

Eagle, J., Liu, Y., Naruoka, Y., Liu, W., Ruff, T., Hooker, M., Sthapit, S., Marston, E., Marlowe, K., Pumphrey, M. and See, D.R., 2022. Identification and Mapping of Quantitative Trait Loci Associated with Stripe Rust Resistance in Spring Club Wheat Cultivar JD. Plant Disease, 106(9), pp.2490-2497.

El-Naggar, M.E.; Abdel salam, N.R.; Fouda, M.M.G.; Mackled, M.I.; Al-Jaddadi, M.A.M.; Ali, H.M.; Siddiqui, M.H.; Kandil, E.. 2022.Response of Bread Wheat Cultivars Inoculated with Azotobacter Species under Different Nitrogen Application Rates.

Erenstein, O., Jaleta, M., Mottaleb, K.A., Sonder, K., Donovan, J. and Braun, H.J., 2022. Global trends in wheat production, consumption and trade. In Wheat improvement: food security in a changing climate (pp. 47-66). Cham: Springer International Publishing.

Esayas L 2015. Effect of Blended Fertilizers on Yield and Yield Traits of Durum Wheat (*Triticum turgidum L. Var. durum*) Varieties in Ada District, Central Ethiopia, MSc thesis, Haramaya University.

F.A., Shaheen, A.M., Abd El-Samad, E.H. and Sawan, O.M., 2012 Rizk, F.A., Shaheen, A.M., Abd El-Samad, E.H. and Sawan, O.M., 2012. Effect of different nitrogen plus phosphorus and sulphur fertilizer levels on growth, yield and quality of onion (*AIlium cepa L.).* Journal of Applied Sciences Research, 8(7), pp.3353-3361.

Fikadu-Lebeta, W., Diriba-Shiferaw, G. and Mulualem-Azene, M., 2019. The need of integrated nutrient management for coriander (*Coriandrum sativum L.)* production. International Journal of Food & Nutrition, 4(1), pp.1-13.

Firehiwot, G., 2014. Yield response to bread wheat (*Triticum aestivum L.)* to applied levels of inorganic N and P fertilizers at Haramaya, eastern Hararghe zone of Oromia Regional State, eastern Ethiopia (Doctoral dissertation, MSc Thesis, Alemaya University, Alemaya Ethiopia).

Firomsa, T., Husien, A., Assefa, K., Abera, T., Lemma, A. and Hundessa, C., 2020. Effect of phosphorus and determination of optimum nitrogen for bread wheat in Kofele District, West Arsi Zone of Oromia, Ethiopia. Journal of Scientific Agriculture, 4, pp.34-37.

Food and Agricultural Organization of the United Nations 2022.FAOSTAT Statistics Database (FAO) (available at: www. fao.org/faostat/en/#data/QCL) (Accessed 27 September

Gebremedhin, T., 2019.Response of Bread Wheat (*Triticum Aestivium L.)* Yield and Yield Components to Different Level of Phosphorous in, 8(1), pp. 23–26. doi:10.11648/j.aff.20190801.14.

Gibson, L. and Benson, G., 2002. Origin, history, and uses of oat (Avena sativa) and wheat (*Triticum aestivum)*. Iowa State University, Department of Agronomy, p.3p.

Giovani Benin1*, Elesandro Bornhofen2, Eduardo Beche1, Eduardo Stefani Pagliosa1, C.L. da S. and C.P., 2012.Acta Scientiarum Agronomic performance of wheat cultivars in response to nitrogen fertilization levels," pp. 275–283. doi:10.4025/ actasciagron.v34i3.14468.

Gizaw, W. and Assegid, D., 2021. Trend of cereal crops production area and productivity, in Ethiopia. *Journal of Cereals and Oilseeds*, *12*(1), pp.9-17.

Gnyp, M.L., Miao, Y., Yuan, F., Ustin, S.L., Yu, K., Yao, Y., Huang, S. and Bareth, G., 2014. Hyperspectral canopy sensing of paddy rice aboveground biomass at different growth stages. Field Crops Research, 155, pp.42-55.

Goda*, D.D., 2021.Agronomic and Economic Performance of Bread Wheat (*Triticum aestivum L.)* Varieties in Response to N-Fertilizer Rate at Lemu-Bilbilo District , Southeastern Ethiopia, pp. 1262–1270. doi:10.32474/CIACR.2021.09.000320.

Goda, D.D., 2022. Influence of Nitrogen Fertilizer Levels on Growth and Development of Bread Wheat (*Triticum aestivum L.)* Varieties at Kulumsa, South-Eastern Ethiopia. *American Journal of Life Sciences*, *10*(2), pp.21-27.

Govindan, V., Gupta, O.P., Kumar, S., Mishra, C.N. and Singh, G., 2023. Wheat Nutraceutomics: Breeding, Genomics, Biotechnology, and Nanotechnology. In Compendium of Crop Genome Designing for Nutraceuticals (pp. 61-83). Singapore: Springer Nature Singapore.

Govumoni, S.P., Koti, S., Kothagouni, S.Y., Venkateshwar, S. and Linga, V.R., 2013. Evaluation of pretreatment methods for enzymatic saccharification of wheat straw for bioethanol production. Carbohydrate polymers, 91(2), pp.646-650.

Guarin, J.R., Martre, P., Ewert, F., Webber, H., Dueri, S., Calderini, D., Reynolds, M., Molero, G., Miralles, D., Garcia, G. and Slafer, G., 2022. Evidence for increasing global wheat yield potential. *Environmental Research Letters*, *17*(12), p.124045.

Gudina, M.H. and Alemu, E.A., 2023. Climate Smart Agriculture Practices and Factors Affecting Its Adoption the Case of Welmera Woreda, Oromia Region, Ethiopia.

Guo, Z., Zhao, Y., Röder, M.S., Reif, J.C., Ganal, M.W., Chen, D. and Schnurbusch, T., 2018. Manipulation and prediction of spike morphology traits for the improvement of grain yield in wheat. Scientific reports, 8(1), p.14435.

Haile*, Tekle Lombamo Wassie, Amsal and Tanner,, 2018.Response of Tef (Eragrostis tef (*Zucc.)* Trotter) to Blended," 8(13), pp. 34–39.

Haile, B., Mekonnen, D., Choufani, J., Ringler, C. and Bryan, E., 2022. Hierarchical modelling of small-scale irrigation: constraints and opportunities for adoption in Sub-Saharan Africa. *Water Economics and Policy*, *8*(01), p.2250005.

Hailu H, Tekalign M, Riikka K, Erik K, Heluf G, Taye B., 2015. Soil fertility status and wheat nutrient content in Vertisol cropping systems of central highlands of Ethiopia. Agriculture and Food Security 4(19):1-10.

Harfe, M., 2017.Response of bread wheat (*Triticum aestivum L.)* Varieties to N and P fertilizer rates in Ofla district," 12(19), pp. 1646–1660.doi:10.5897/AJAR2015.10545.

Hawkes ford, M.J., 2014.Reducing the reliance on nitrogen fertilizer for wheat production, Journal of Cereal Science, 59(3), pp. 276–283. doi:10.1016/j.jcs.2013.12.001.

Hirel B, J Le Gouis, B Ney, A.G., 2007, 2018.Response of Bread Wheat (*Triticum aestivum L.)* to Application of Slow Releasing Nitrogen Fertilizer in Tigray Nitrogen (N) is often the most limiting nutrient for crop yield in many regions of, 28(1), pp. 111–126.

Hirel, B. and Lea, P.J., 2018. Genomics of nitrogen use efficiency in maize: From basic approaches to agronomic applications. The Maize Genome, pp.259-286.

Hoogenboom G.; Porter, C.H.; Shelia, V.; Boote, K.J.; Singh, U.; White, J.W.; Hunt, L.A.; Ogoshi, R.; Lizaso, J.I.; Koo, J.,2019.Decision support system for agro technology transfer (DSSAT) version 4.7. DSSAT Found. Gainesv. Florida. USA.. Available

Hordofa, M., 2020. Blended fertilizers validation based on Ethio-SIS soil fertility map at Halaba, Southern Ethiopia. International Journal of Innovative Agriculture & Biology Research, 8(3), pp.1-6.

Hunt, J.R., Hayman, P.T., Richards, R.A. and Passioura, J.B., 2018. Opportunities to reduce heat damage in rain-fed wheat crops based on plant breeding and agronomic management. Field Crops Research, 224, pp.126-138.

Hussain, S., Farooq, M., Wahid, M. A., & Wahid, A., 2013 (2019).Grain quality and yield response of bread wheat (*Triticum aestivum L.)* Varieties to different rates of blended fertilizer at Kulumsa , South-eastern Ethiopia,4(August), pp. 120–133.

Irfan, M., Abbas, M., Shah, J.A. and Memon, M.Y., 2018. Grain yield, nutrient accumulation and fertilizer efficiency in bread wheat under variable nitrogen and phosphorus regimes. Journal of Basic and Applied Sciences, 14, pp.80-86.

Ishete, T.A. and Tana, T., 2019. Growth, yield component and yield response of durum wheat (*Triticum turgidum L. var. Durum*) to blended NPS fertilizer supplemented with N rates at Arsi Negelle, Central Ethiopia. African Journal of Plant Science, 13(1), pp.9-20.

Itelima, J.U., Bang, W.J., Onyimba, I.A., Sila, M.D. and Egbere, O.J., 2018. Bio-fertilizers as key player in enhancing soil fertility and crop productivity: A review.

Iticha, B., Mosley, L.M. and Marschner, P., 2024. Combining lime and organic amendments based on titratable alkalinity for efficient amelioration of acidic soils. Soil, 10(1), pp.33-47.

Jankowski, K.J., Kijewski, L., Groth, D., Skwierawska, M. and Budzynski, W.S., 2015.The effect of sulfur fertilization on macronutrient concentrations in the post-harvest biomass of rapeseed (*Brassica napus L. ssp. oleifera Metzg*). Journal of Elementology, 20(3).)

Jat, L.K., Singh, Y.V., Meena, S.K., Meena, S.K., Parihar, M., Jatav, H.S., Meena, R.K. and Meena, V.S., 2015. Does integrated nutrient management enhance agricultural productivity. J Pure Appl Microbiol, 9(2), pp.1211-1221.

JEMAL, A.M., Ahmad, A.P. and Adare, K., 2020. Effects of Blended NPS Fertilizer Rates on Yield Components And Yield of Bread Wheat (*Triticum Aestivum L.)* Varieties At Jarso District, Eastern Ethiopia (Doctoral Dissertation, Haramya University).

Kebede, B., Amare, G. and Korji, D., 2021.Popularization of Sanate Bread Wheat Variety in the Highlands of Guji Zone, Southern Oromia, Ethiopia,(3), pp. 25–30.

Khan MA, Hussain I, Baloch MS. 1999.Wheat yield potential current status and future strategies. Pak J Biol Sci.;3(1):82-6. DOI: 10.3923/pjbs.2000.82.86

Kumera Terfa, T.A. and D.N., 2020.Effects of Seed Rates and Sowing Methods on Phenology, Growth, Yield and Economic Feasibility of Bread Wheat (*Triticum aestivum L* .) Varieties in Abbay Chommen District, Western Oromia , Ethiopia Natural Resources Management Research Process, Ambo Ag,13(3), pp. 64–77. doi:10.5829/idosi.ajps.2020.13.3.64.77.

Landon, J.R., 1991. Booker tropical soil manual; a handbook for soil survey and agricultural land evaluation in the tropics and subtropics.

Lawal, M.A., Abdulrahman, B.L. and Mustapha, A.A., 2022. Sulphur Mineralization Under Organic Matter And Elemental Sulphur Treatment In Soils Of Wudil And Gaya Lgas Of Kano State, Nigeria. Pat, 18(2), Pp.1-9.

Lemi Aga Duressa and Negash Geleta Ayana: Effects of variety and fertilizer rate on yield of Bread Wheat (*Triticum aestivum, L*) Varieties in East Wollega Zone, Western

Ethiopia. Journal of Agricultural and Biological Sciences Vol. 6, No. 2, 2020, pp. 60-71

Levy, A.A. and Feldman, M., 2022. Evolution and origin of bread wheat. The Plant Cell, 34(7), pp.2549-2567.

Liben, M.; Assefa, A.; Tadesse, T.; Mariye, A., 2004.Response of Bread Wheat to Nitrogen and Phosphorous Fertilizers at DifferentAgro-ecologies of Northwestern Ethiopia. In Proceedings of the 12th Regional Wheat Workshop for Eastern, Central and Southern Africa, Nakuru, Kenya, 22–26 November; p. 41

Lulie, B., Yakob, A., Hordofa, M. and Nigussie, A., 2020. Effects of Nitrogen and Phosphorous Fertilizer Rate on Growth, Biomass and Yield of Sage (*Saliva officinal's L.*) at Wondo Genet and Koka, Ethiopia. Results of Natural Resources Management Research.

Mankin, K.R., Edmunds, D.A., McMaster, G.S., Fox, F., Wagner, L.E. and Green, T.R., 2023. Winter Wheat Crop Models Improve Growth Simulation by Including Phenological Response to Water-Deficit Stress. Environmental Modeling & Assessment, pp.1-14.

Maqsood, M., Shehzad, M.A., Asim, A. and Ahmad, W., 2012. Optimizing rate of nitrogen application for higher growth and yield of wheat (*Triticum aestivum L.)* cultivars. Pakistan Journal of Agricultural Science, 49, pp.491-496.

Markos, G. and Tana, P., 2019. Effects of blended NPSB fertilizer rates on yield and yield related traits of bread wheat (*Triticum aestivum L.)* varieties in Kedida Gamela district, southern Ethiopia (Doctoral dissertation, Haramaya university).

Marschner., 2010.Assessment of Bread Wheat Production, Marketing and Selection of N-Efficient Bread Wheat (*Tritium aestivum L.*) Varieties for Higher Grain Yield and Quality in North Western Ethiopia Assessment of Bread Wheat Production, Marketing and Selection of N-E.

Masebo, N. and Menamo, M., 2016. The effect of application of different rate of np fertilizers rate on yield and yield components of sorghum (Sorghum bicolor): Case of Derashe Woreda, SNNPR, Ethiopia. Journal of Natural Sciences Research, 6(5), pp.88-94..

Masood, S.A., Ahmad, S., Kashif, M. and Ali, Q., 2014. Correlation analysis for grain and its contributing traits in wheat (*Triticum aestivum L.).* Nat Sci, 12(11), pp.168-176.

McArthur, J.W. and McCord, G.C., 2017. Fertilizing growth: Agricultural inputs and their effects in economic development. Journal of development economics, 127, pp.133-152.

Meena, H.S., Kumar, D. and Prasad, S.R., 2014. Genetic variability and character association in bread wheat (Triticum aestivum). Indian Journal of Agricultural Sciences, 84(4), pp.487-91.

Melesse H.,2017.Response of bread wheat (*Triticum aestivum L.)* varieties to N and P fertilizer rates in Ofla district, Southern Tigray, Ethiopia. African Journal of Agricultural Research 12(19):1646-1660.

Menamo., M. 2016.The Effect of Application of Different Rate N-P Fertilizers Rate on Yield and Yield Attributes of Bread Wheat in Case of Chancha6(5), pp. 63–66.

Mengel, K., Kirkby, E.A., Kosegarten, H. and Appel, T., 2001. The soil as a plant nutrient medium. *Principles of plant nutrition*, pp.15-110.

Mengistu B,m.,2015. Growth, Yield, and Grain Quality of Durum Wheat (*Triticum turgidum L.var. durum*) Varieties as influenced by Nitrogen Application in Sinana, South-eastern Ethiopia. MSc thesis, Haramaya University.

Meyer, M., Bacha, N., Tesfaye, T., Alemayehu, Y., Abera, E., Hundie, B., Woldeab, G., Girma, B., Gemechu, A., Negash, T. and Mideksa, T., 2021. Wheat rust epidemics damage Ethiopian wheat production: A decade of field disease surveillance reveals national-scale trends in past outbreaks. *PLoS One*, *16*(2), p.e0245697.

Mohammadi, E., Movahedi, S., Mohammadi, R. and Golkari, S., 2022. Assessment of the occurrence of climate change and its effects on planting date and growth duration of rainfed wheat in the western and northwestern regions of Iran. *Paddy and Water Environment*, *20*(2), pp.241-253.

Mohammadi, R. and Golkari. S., 2022.Genetic resources for enhancing drought tolerance from a mini-core collection of spring bread wheat (Triticum aestivum L.),Acta Scientiarum - Agronomy, 44(1978), pp. 1–15. doi:10.4025/actasciagron.v44i1.56129.

Naseri, R., Mirzaei, A., Soleimani, R. and Nazarbeygi, E., 2010. Response of bread wheat to nitrogen application in calcareous soils of western Iran. Am-Eurasian J. of Agric. Env. Sci, 9(1), pp.79-85.

Nemat A. Noureldin a, H.S. Saudy a,*, F. Ashmawy b, H.M.S. b., 2013.Grain yield response index of bread wheat cultivars as influenced by nitrogen levels, Annals of Agricultural Sciences, 58(2), pp. 147–152. doi:10.1016/j.aoas.2013.07.012.

Nigussie, Z., Tsunekawa, A., Haregeweyn, N., Adgo, E., Nohmi, M., Tsubo, M., Aklog, D., Meshesha, D.T. and Abele, S., 2017. Farmers' perception about soil erosion in Ethiopia. *Land degradation & development*, *28*(2), pp.401-411.

Olsen, S.R., 1954. Estimation of available phosphorus in soils by extraction with sodium bicarbonate (No. 939). US Department of Agriculture.

Ookawa, T., Naruoka, Y., Yamazaki, T., Suga, J. and Hirasawa, T., 2003. A comparison of the accumulation and partitioning of nitrogen in plants between two rice cultivars, Akenohoshi and Nipponbare, at the ripening stage. Plant Production Science, 6(3), pp.172-178.

Pequeno, D.N., Hernandez-Ochoa, I.M., Reynolds, M., Sonder, K., MoleroMilan, A., Robertson, R.D., Lopes, M.S., Xiong, W., Kropff, M. and Asseng, S., 2021. Climate impact and adaptation to heat and drought stress of regional and global wheat production. *Environmental Research Letters*, *16*(5), p.054070.

Prasad, P.V.V., Boote, K.J., Allen Jr, L.H., Sheehy, J.E. and Thomas, J.M.G., 2006. Species, ecotype and cultivar differences in spikelet fertility and harvest index of rice in response to high temperature stress. Field crops research, 95(2-3), pp.398-411.

Prystupa, P., Slafer, G.A. and Savin, R., 2003. Leaf appearance, tillering and their coordination in response to NxP fertilization in barley. Plant and Soil, 255, pp.587-594.

Ra, S., Oddy, J. and Halford, N.G. (2020) “The Sulphur Response in Wheat Grain and Its Implications for Acrylamide Formation and Food Safety.”

Rahman MA, Sarker MAZ, Amin MF, Jahan AHS, Akhter MM., 2011. Yield response and nitrogen use efficiency of wheat under different doses and split application of nitrogen fertilizer. Bangladesh Journal of Agricultural Research 36(2):231-240.

Reynolds M and Braun H (ed) 2013. Proc. ofthe 3rd Int. Workshop ofthe Wheat Yield Consortium (Ciudad Obregon: International Maize and Wheat Improvement Center (CIMMYT) Mexico)

Sadia, S., Zubair, M., Tariq, A., Zeng, F., Graciano, C., Ullah, A., Ahmed, Z., Zhang, Z. and Ismoilov, K., 2023. Agricultural Production Relation with Nutrient Applications. Plant Ionomics: Sensing, Signaling, and Regulation, pp.19-29.

Selim, M.M., 2020. Introduction to the integrated nutrient management strategies and their contribution to yield and soil properties. International Journal of Agronomy, 2020.

Senbeta, A.F. and Worku, W., 2023. Ethiopia's wheat production pathways to self-sufficiency through land area expansion, irrigation advance, and yield gap closure. *Heliyon*.

Shah WA, Khan HU, Anwar S, Nawab K 2011. Yield and yield components of wheat as affected by different seed rates and nitrogen levels. Sarhad Journal of Agriculture 27(1):17-25.

Sharma, I., Tyagi, B. S., Singh, G., Venkatesh, K., & Gupta, O. P. (2015). Enhancing wheat production-A global perspective. The Indian Journal of Agricultural Sciences, 85(1), 03-13.

Shazma AI, Babar I, Asad AK, ImranW AS, Mohammad I, Wajid AK, Ikramullah WA, Wasim A., 2016. Nitrogen and phosphorus fertilization of improved varieties for enhancing Phenological traits of wheat. Pure and Applied Biology 5(3):511-519.

Shazma Anwar, S.A., Israeel, I., Babar Iqbal, B.I., Khan, A.A., Imran, I., Shah, W.A., Mohammad Islam, M.I., Khattak, W.A., Ikramullah, I., Wasim Akram, W.A. and Wasim Abbas, W.A., 2016. Nitrogen and phosphorus fertilization of improved varieties for enhancing phenological traits of wheat.

Shen, J., Yuan, L., Zhang, J., Li, H., Bai, Z., Chen, X., Zhang, W. and Zhang, F., 2011. Phosphorus dynamics: from soil to plant. Plant physiology, 156(3), pp.997-1005.

Sigaye, M.H., Mekuria, R. and Kebede, K., 2022. Effect of NPS-B Blended and Nitrogen Fertilizers Application on Bread Wheat Yield and Economic Profitability on Nitisol of Southern, Ethiopia.

Singh nee' Nigam, P., Gupta, N. and Anthwal, A., 2009. Pre-treatment of agro-industrial residues. Biotechnology for agro-industrial residues utilisation: Utilisation of agro-residues, pp.13-33.

Slafer, G.A., Savin, R. and Sadras, V.O., 2023. Wheat yield is not causally related to the duration of the growing season. European Journal of Agronomy, 148, p.126885.

Stewart, W.M., Dibb, D.W., Johnston, A.E. and Smyth, T.J., 2005. The contribution of commercial fertilizer nutrients to food production. Agronomy journal, 97(1), pp.1-6.

Tadesse, K.; Ayalew, A.; Badebo, A., 2010.Effect of fungicide on the development of wheat stem rust and yield of wheat varieties in highlands of Ethiopia. Afri. Crop Sci. J., 18, 23–33

Tadesse, W., Zegeye, H., Debele, T., Kassa, D., Shiferaw, W., Solomon, T., Negash, T., Geleta, N., Bishaw, Z. and Assefa, S., 2022. Wheat production and breeding in ethiopia: retrospect and prospects. *Crop Breeding, Genetics and Genomics*, *4*(3).

Tagesse, A., B. Ketema and T. Tamado, 2018. Effect of Blended NPS Fertilizer Supplemented with Nitrogen on Yield Components and Yield of Bread Wheat (*Triticum aestivum L.).* Journal of Natural Sciences Research, 18(11): 90-96.

Terfa, A.E., Mellisse, B.T., Kebede, M.M., Elias, E. and Yadessa, G.B.2023.Effect of Blended Fertilizer Application on Bread Wheat Yield and Profitability on Andosols of Southwestern Highlands of Ethiopian, *Communications in Soil Science and Plant Analysis*, 54(1), pp. 73–82. doi:10.1080/00103624.2022.2109664.

Tesfaye, S.; Bedada, B.; Mesay, Y., 2016.Impact of improved wheat technology adoption on productivity and income in Ethiopia. Afr.Crop Sci. J., 24, 127–135;

Teshome, W., 2020. Impact of nitrogen fertilizer on growth and yield of durum wheat(*Triticum turgidum L.*) at Butajira Ethiopia. Int. J. Adv. Res. Biol. Sci, 7(3), pp.7-16.

Tilahun Abera and Tamado Tana. 2019. Growth, yield component and yield response of durum wheat (*Triticum turgidum L. var. Durum*) to blended NPS fertilizer supplemented with N rates at Arsi Negelle, Central Ethiopia. Vol. 13 (1), pp. 9-20, January 2019

Tilahun Abera Ishete and Tamado Tana,2019. Growth, yield component and yield response of durum wheat (*Triticum turgidum L.var. Durum)* to blended NPS fertilizer supplemented with N rates at Arsi Negelle, Central Ethiopia, African Journal of Plant Science, Vol. 13(1), pp. 9-20.

Till A.R., 2010.Sulphur and sustainable agriculture, International Fertilizer Industry Association.

UDDIN, M.S., Kamrun, N., Ali, M.R., Bagum, S.A. and Banik, B.R., 2010. Phenotypic stability of kernel yield in maize. International Journal of Sustainable Agricultural Technology, 6(1), pp.35-37

UHR, Z., Dimitrov, E., Dragov, R. And Chipilski, R., 2023. Comparative Testing Of Old Winter Wheat Varieties Under Changing Climatic Conditions. Scientific Papers. Series A. Agronomy, 66(1).

Usman Kedir1*, Tamado Tana2, W.W., 2020.Effects of Blended (NPSB) Fertilizer Rates on Yield Components, Yield and Grain Quality of Bread Wheat (*Triticum Aestivum L.)* Varieties at Kulumsa, South-Eastern Ethiopia,8(9), pp. 14–27.

Venske, E., Dos Santos, R.S., Busanello, C., Gustafson, P. and Costa de Oliveira, A., 2019. Bread wheat: a role model for plant domestication and breeding. Hereditas, 156(1), pp.1-11

Walkley, A. and Black, I.A., 1934. An examination of the Degtjareff method for determining soil organic matter, and a proposed modification of the chromic acid titration method. Soil science, 37(1), pp.29-38.

Wang H., Zhang, Y., Chen, A., Liu, H., Zhai, L., Lei, B. and Ren, T., 2017. An optimal regional nitrogen application threshold for wheat in the North China Plain considering yield and environmental effects. Field Crops Research, 207, pp.52-61.)

Wang, X., Christensen, S., Svensgaard, J., Jensen, S.M. and Liu, F., 2020. The effects of cultivar, nitrogen supply and soil type on radiation use efficiency and harvest index in spring wheat. Agronomy, 10(9), p.1391.

Winsemius, H.C., Aerts, J.C., Van Beek, L.P., Bierkens, M.F., Bouwman, A., Jongman, B., Kwadijk, J.C., Ligtvoet, W., Lucas, P.L., Van Vuuren, D.P. and Ward, P.J., 2016. Global drivers of future river flood risk. Nature Climate Change, 6(4), pp.381-385.

Xiang, Y.A.N., Jin, J.Y., Ping, H.E. and Liang, M.Z., 2008. Recent advances on the technologies to increase fertilizer use efficiency. Agricultural Sciences in China, 7(4), pp.469-479.

Yang, X., Lu, Y., Ding, Y., Yin, X. and Raza, S., 2017. Optimising nitrogen fertilisation: A key to improving nitrogen-use efficiency and minimising nitrate leaching losses in an intensive wheat/maize rotation (2008–2014). Field Crops Research, 206, pp.1-10.

Yohannes E., 2014.Effect of Rates and Time of Nitrogen Application on growth, Yield, and Grain Protein of Bread Wheat (*Triticum aestivum L.)* in Eastern Hararghe, Ethiopia. MSc Thesis, Haramaya University.

Zelleke, G., Agegnehu, G., Abera, D. and Rashid, S., 2019. Fertilizer and soil fertility potential in Ethiopia. Gates Open Res, 3(482), p.482.

Zhang, L., He, X., Liang, Z., Zhang, W., Zou, C. and Chen, X., 2020. Tiller development affected by nitrogen fertilization in a high-yielding wheat production system. Crop Science, 60(2), pp.1034-1047.

Zhao, X., Guo, Y., Kang, L., Yin, C., Bi, A., Xu, D., Zhang, Z., Zhang, J., Yang, X., Xu, J. and Xu, S., 2023. Population genomics unravels the Holocene history of bread wheat and its relatives. Nature Plants, 9(3), pp.403-419

7. APPENDICES

Appendex Table 1Mean squares of ANOVA table for soil chemical properties

Source of vaiance	DF	PH	OC	TN	AP	AS	CEC
Rep	2	0.217ns	0.511**	0.047ns	112.99	0.000018ns	102.28ns
Trt	12	0.167ns	0.081ns	0.026ns	1972.777**	0.000766ns	84.778ns
Error	24	0.319	0.086	0.028	375.56	0.0013	65.04

*** Highly significant different at (0.0001);** high significant different at (alpha 0.001);*significant differences at (0.05) – not significant different at (P-value (0.05).

Appendex Table 2 Mean squares of ANOVA table for the day of 50% headingand day of 90% Physiological maturity of bread wheat

Source of variance	DF	DH	DPM
Rep	2	0.64ns	3.41ns
Trt	12	38.92**	61.897***
Error	24	6.97	6.41

*** Highly significant different at (0.0001);** high significant different at (alpha 0.001);*significant differentness at (0.05) – not significant different at (P-value (0.05).

Appendex Table 3 Mean squares of ANOVA table for plant height (PH), number of tiller per plant (NTP) and spike length per plant (SLP) of bread wheat

Source of variance	DF	PH	NTTP	SLP
Rep	2	7.95ns	0.22***	0.27***
Trt	12	46.12***	2.7***	3.16***
Error	24	3.15	0.004	0.0100

*** Highly significant different at (0.0001);** high significant different at (alpha 0.001);*significant differentness at (0.05) – not significant different at (P-value (0.05)

Appendex Table 4 Mean squares of ANOVA table for the yield and yield components of bread wheat

Source	DF	ETP	SPS	*NGS*	TSW	AGBM	SY	HI	GYqth-1
Rep	2	0.13***	0.55ns	0.51ns	7.03ns	1.33ns	2.09ns	57.9*	578975.29***
Trt	12	2.98***	6.214***	137.6***	18.8*	11.81***	8.852**	125.53***	1735128.39***
Error	24	0.006619	0.184	1.19	5.73	1.743	1.631	11.89	34565.33

*** Highly significant different at (0.0001);** high significant different at (alpha 0.001);*significant differentness at (0.05)– not significant different at (P-value (0.05)

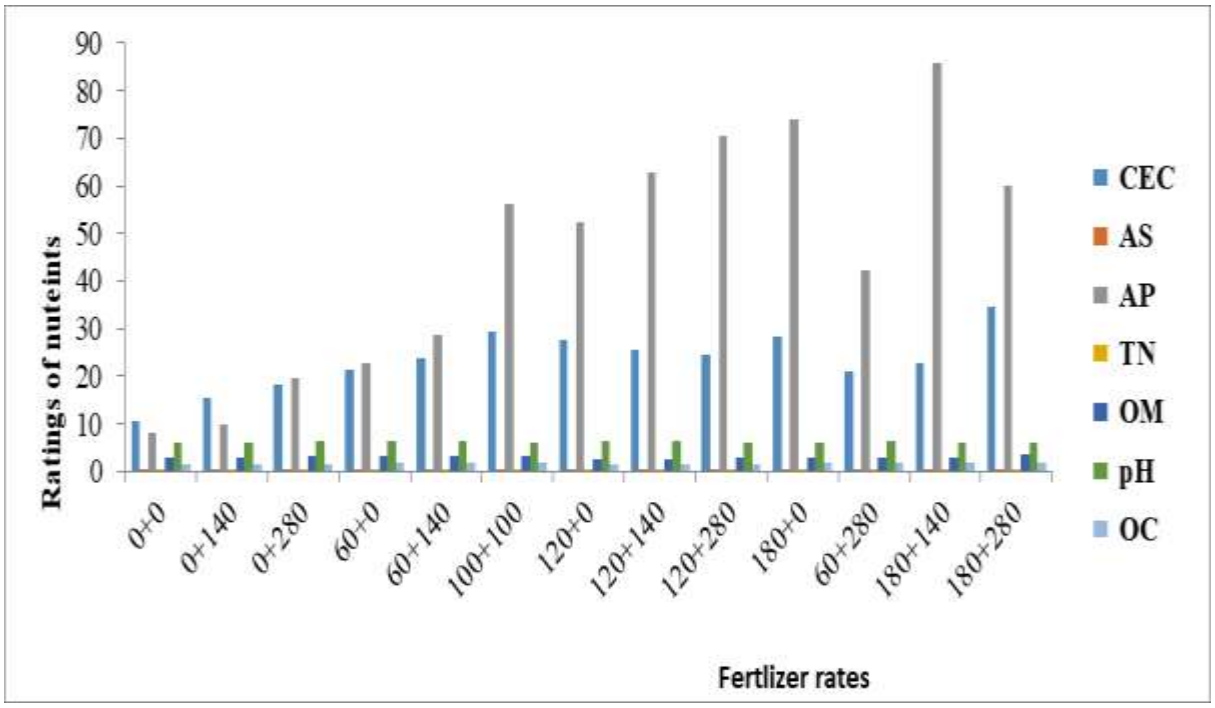
Appendix Figure 1 List of Supplementery figures(photos) during urea application

Appendix Figure 2 List of Supplementery figures(photos) during data collection application

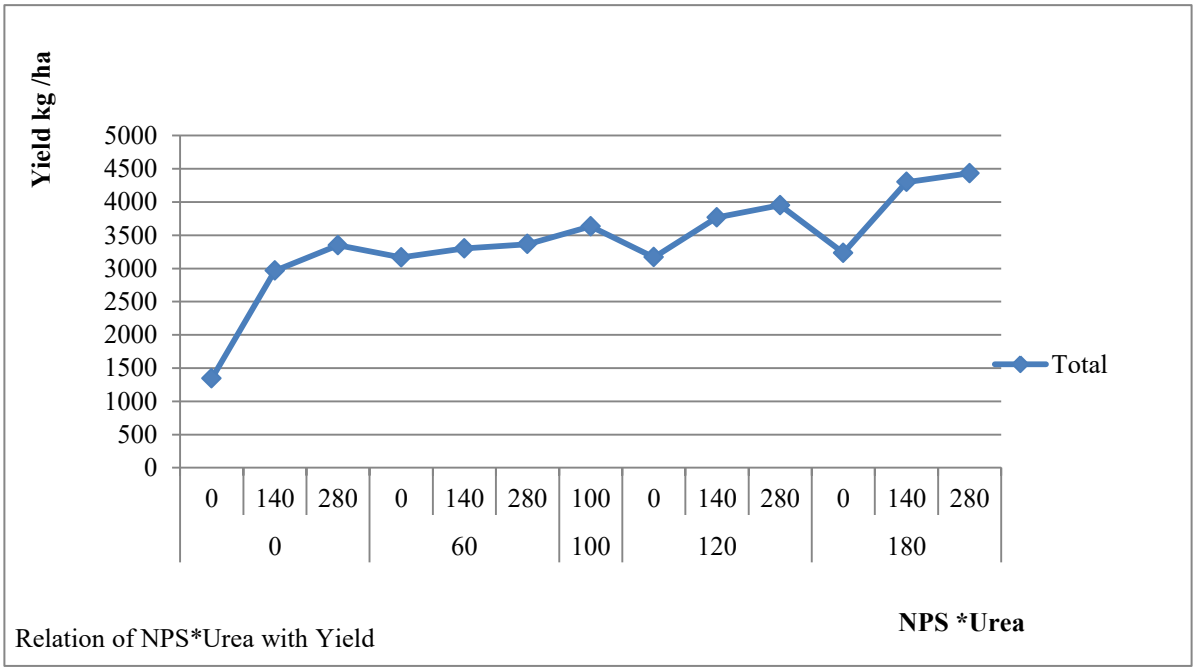
Appendix Figure 3 List of Supplementery figures(photos) during grand soil sample

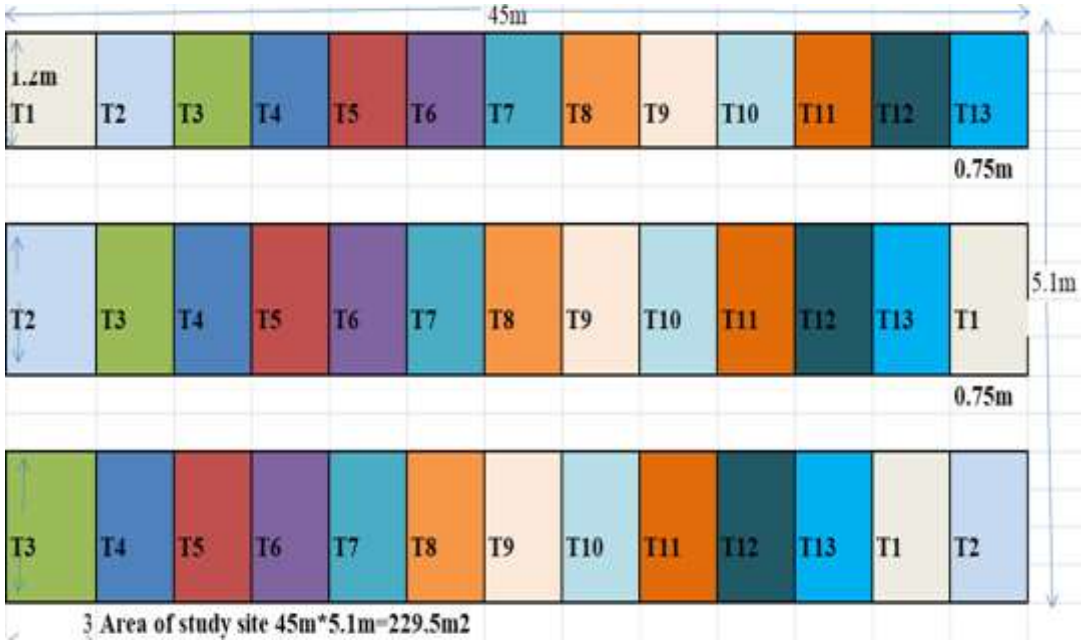
Appendix Figure 4 List of Supplementery figures(photos) during soil sample analysis in laboratory

Appendix Figure 5 The effect of NPS and Urea fertilizer rate affects on soil chemical properties after harvest.



Appendix Figure 6 The effect of NPS and urea fertilizer rate affects on Gain yield



Relation of NPS*Urea with Yield

Appendix Figure 7 Field lay out