Original Research Article

SEEDING AND BLENDED NPSB WITH NITROGEN FERTILIZER COMBINED RATES EFFECT ON GROWTH, YIELD AND YIELD COMPONENTS OF BREAD WHEAT (*Triticum aestivum*L.*)* IN SOUTH ARI, SOUTHERN ETHIOPIA

ABSTRACT

Wheat is one of the most important cereal crops in South Ari, Ethiopia. However, the productivity is below the national and regional level due to in adequate seeding rates and soil nutrition. Therefore, a study was conducted to determine rate of seeding and blended NPSB fertilizer and nitrogen on growth, yield and yield components of wheat during 2021-2022 cropping seasons. The experiment consisted of three Seeding rates (50, 100, and 150 kg ha^{-1}), four rates of blended NPSB (0,100, 200 and 300 kg ha^{-1}) combined with two rates of Nitrogen (50 and 100 kgha^{-1}) fertilizer and laid out in split plot design with three replications. The results showed that phenology; growth, yield and yield components of wheat significantly affected by seeding rate and blended NPSB with N fertilizer combined rates. Increasing seeding rate and blended NPSB with nitrogen fertilizer combined rate resulted increase in crop phenology, growth, yield and yield components except harvest index where maximum was recorded at 100 kg ha^{-1} seeding rate and zero blended with 23 kg ha^{-1} nitrogen combined rate. Therefore, it is concluded that application 100 kg ha^{-1} seeding rate and no blended NPSB combined with 23 kg ha^{-1} nitrogen fertilizer and or 150 kg ha^{-1} seeding rate and 200 kg ha^{-1} blended NPSB with 23 kg ha^{-1} combined rate found to be significant to impact wheat growth and yield at South Ari. However, further study requested in different seasons and locations under extended rates to exploit the recommendation of present study.

Keywords: South Ari, wheat, fertilizer rate, seeding

1. Introduction

Wheat (*Triticum aestivu*m L.) is one of the major cereal crops grown in Ethiopia covering 1.87 million hectares of land and 3.1 t/ha average productivity following maize and sorghum (CSA, 2021). It is mainly cultivated in a wide range of soil conditions and at altitudes ranging from 1500 to 300 meters above sea level (Gashaw *et al.*, 2018). The FAO Africa and global estimate of wheat production was 9.6 million hectares and 3.2 t/ha 220425413 million hectares 3.51 t/ha, respectively (FAO, 2021). It is also one of the major cultivated crops around Ari with estimated production and productivity of 7125 hectares of land and 2.1t/ha, respectively which is quite below the national estimate. This is because of poor soil nutrition and lack of site specific time and rate of fertilizer application and crop management practices (Schneider and Anderson, 2010). Characteristics of agricultural productivity, in general, is also quite low due to high level of nutrient mining, low use of external inputs, conventional farm management practice and limited capacity (Agegnehu *et al.*, 2016).

Besides, wheat seeding rate is an agronomic factor which was not emphasized during planting for maximum yield of the crop. The genetic potential of a wheat crop was mainly constrained due to competition for resources, where the biomass production and grain yield of individual plants significantly affected. Competition for resources also significantly affect production of tillers and number of kernels per plant and per unit area (Naseri *et al*,. 2012). Maintaining population of a crop per unit area of land encourages nutrient consumption efficiency, enhances fixing sun light for photosynthesis, good soil and soil nutrients uptake and water use efficiency and consequently increases the production and productivity of the crop (Alemayehu, 2015). On the other hand, the biological and scientific truth of maximum seeding rate (population) towards increased crop yield is conditioned through improved crop management (soil fertility management), crop genetics, and environment where the crop is subjected to grow. Thus, examining agronomic requirements of a wheat variety as like planting density need to be essential across various agro-ecologies and for specific conditions (Nizamani *et al.*, 2014).

The nutrient mining due to sub optimal fertilizer application in one hand and unbalanced fertilizer composition on the other hand emerged multi nutrient deficiency in Ethiopian soils (Haile & Boke, 2011). The national soil data base also indicated that the macronutrients, due to repeated cultivation, and the micronutrients like zinc, boron, and copper were depleted from the soil of major crop producing area of the country (EthioSIS, 2014). Urea and Di-ammonium phosphate (DAP) was the only inorganic fertilizer sources used to maintain soil fertility of Ethiopian agriculture. However, it was perceived recently that the production of high protein cereal crops like wheat was limited due to deficiency of S and other nutrients (Menna *et al.,* 2015). Study report also indicated that elements like N, P, K, S and Zn levels as well as B and Cu are becoming depleted and deficiency symptoms are being observed on major crops in different areas of the country (ATA, 2014). Therefore, a move from blanket to site specific fertilizer rate recommendations should customized based on soil type and crop (Minot *et al.,* 2015). The practices of farmers across the country on the types of blended fertilizer (such as NPS, NPSB, etc.) as suggested by EthioSIS and information on application rate is quite limited. Hence, site specific estimation of blended fertilizer combined with nitrogen rate and amount of seeding is essential for wheat production. Therefore, this study was undertaken to determine rates of seeding and blended NPSB with nitrogen fertilizer rate on yield and yield components of bread wheat.

2. MATERIALS AND METHODS

2.1 Study area description

The field experiment was conducted in South Ari located at $5^0$97’64’’N latitude and $36^0$62’44’’E longitude and at an altitude of 2264 m.a.s.l. during 2021/2022 cropping season (Figure 1). The experimental site is attributed with mean monthly rainfall of 290.2 mm and maximum and minimum temperatures of 30.4ºC and 15.3ºC, respectively during the period of the experiment (Figure 2) and soil textural class of clay loam.

2.2 Treatments and design description of experiment

The experiment consisted of four rates of blended NPSB (0, 100, 200 and 300 kg ha^{-1}) and two rates of Nitrogen (50 and 100 kg ha^{-1}) fertilizers and three rates of wheat seeding (50, 100, and 150 kg ha^{-1}). The nutritional content of blended NPSB fertilizer is 18.1% nitrogen, 36.1% phosphorus, 6.7 % Sulfur and 0.71% Boron. The fertilizer UREA (46% N) was used as the source of nitrogen where equivalent treatment rate computed and test wheat variety (Wane) released in 2016 by kulumsa Agricultural research center adapted to areas with annual rain fall of 750-1500 mm and altitudes of 2000-2300m was used for the study. The rates of blended and nitrogen fertilizer were combined to set as one factor with eight levels. The treatments were laid out in split plot design with three replications where rates of seeding assigned as main plot and the combination blended NPSB with nitrogen fertilizer rates assigned as sub plot treatments. Each treatment was randomly assigned to experiment plots each consisting six rows spaced at 0.2 m with 3 m by 1.2 m. sized. The plots were spaced at 0.5m and 1m among blocks.

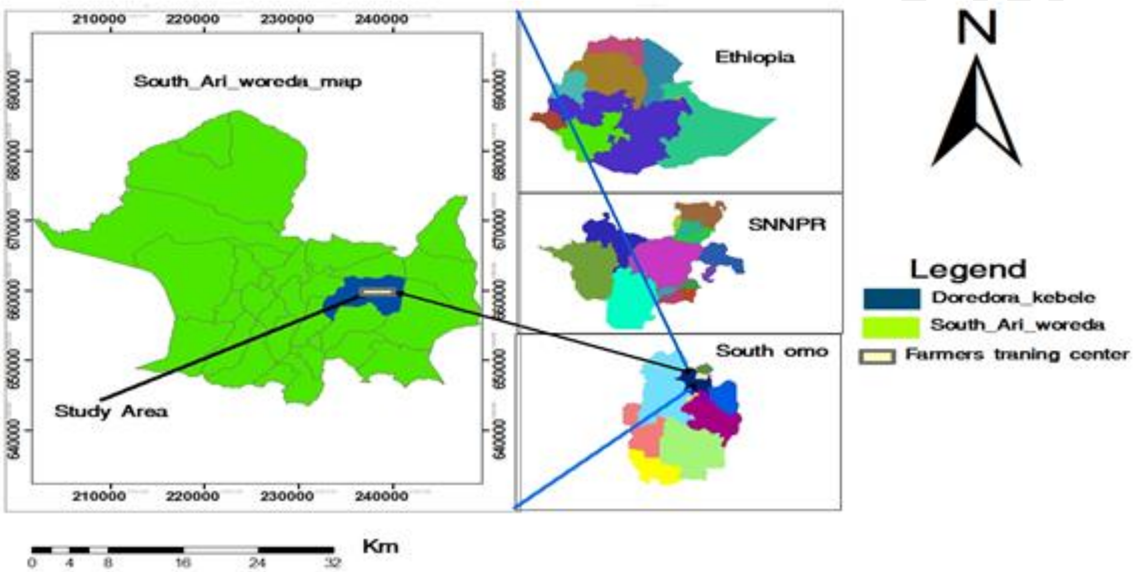

Figure 1. Geographical location of experimental site

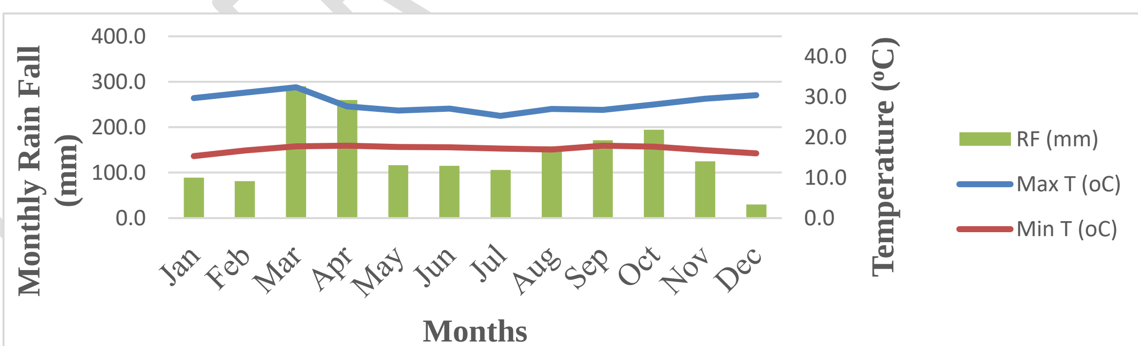

Figure 2. Rainfall, minimum, and maximum temperature distribution of the study area during cropping season

2.3. Physicochemical properties of the experimental site soil

A soil of experimental site was collected randomly at 20 cm depth before sowing. The samples were composited, air dried and crushed to pass a 2mm sieve and used for soil physical and chemical characteristics test with procedures suggested. The soil sample analysis result showed that the experimental site soil attributed with clay loam textural class, pH of 5.3 rated moderate as Tekalign (1991) and CEC of 23 ppm rated medium as Landon (1991). The total nitrogen and available phosphorus was 0.15% and 7.761 ppm, respectively which were rated medium according to Olsen (1954). The organic carbon content, available boron and sulfur was estimated as 3.4%, 0.3891 mg/kg and 6.7352 ppm, respectively with ratings of medium as Walkiley and Black (1934), low as EthioSIS (2014) and very low as Havlin *et al*. (1999), respectively. Therefore, the soil test results indicated the need for application macro and micronutrient nutrition in wheat production.

2.4. Data collection and analysis

Data on wheat phenology [days to heading (DH), days to maturity (DM)]; growth [plant height (PH), number of tiller per plant (NTPP)]; grain yield and yield components [Thousand seed weight (TSW), above ground biomass (BM), harvest index (HI)] were collected and subjected to analysis of variance (ANOVA) with a generalized linear model for factorial experiment in split plot design by SAS software program (SAS version 9.2, 2009). Means of the treatment effects was separated with least significant differences (LSD) at 5 % level of significance.

3. RESULTS AND DISCUSSION

3.1 Crop phenology and growth analysis

Days to heading (DH)

The result of analysis showed that days to heading was significantly ($p \leq 0.05$) affected by seeding rate and combined blended NPSB with nitrogen fertilizer application. The interaction between seeding rates with combined blended NPSB and nitrogen rates was not significant (Table 1). Mean days to heading ranged from 65.6 to 63.4 days due to seeding rate. Significantly high days to heading wa**s** recorded from seed rate of 50 kg ha^{-1} and the minimum was recorded from seed rate of 150 kg ha^{-1}. The result suggested that the earliness to heading attained in high seeding rate might be due to the higher competition to resources.

The findings was in-line with Gafaar (2007) who indicated that increasing sowing density from 200 to 400 grains per square meter in wheat crop significantly decreased the number of days to 50% heading. The effect of seeding rate also revealed that heading started earlier at higher seeding rates (Jemal *et al*., 2015 and Worku, 2008).

Mean days to heading ranged from 62.9 to 67.6 days- due to application of combined blended and nitrogen fertilizer. The maximum days to heading recorded when applying 300 kg ha^{-1} blended NPSB combined with 46 kg ha^{-1} N fertilizer, whereas the minimum was recorded from 100 kg ha^{-1} blended NPSB fertilizer with 23 kg ha^{-1} N fertilizer. The result was on par with the days to heading attained from zero blended combined with nitrogen fertilizer applied at 23 and 46 kg ha^{-1}. The result indicated that days to heading delayed as the rate of fertilizer application increasing suggesting enhanced vegetative growth (delay by 7.03%) due to fertilization, nitrogen application in particular. The resulted was in line with the report of Muhammad *et al.* (2016) who indicated that wheat plants grew under increased rates of nitrogen fertilizer supply delayed days to headings than those grew lower rates of the nutrient. Increasing nitrogen level from zero to 69 kg ha^{-1} showed delayed days to heading, from 67.58 to 70.04 days of bread wheat (Harfe, 2017).

Days to maturity

Analysis of days to maturity showed that seeding rate and combining application of blended and nitrogen fertilizer significantly influenced ($P \leq 0.05$) days to maturity of wheat variety. However, interaction of the factors was not significant on days to wheat maturity (Table 1). The days to maturity ranged from 103.1 to 110.7 days due to seeding rates. The short days to maturity recorded from high seeding rate (150 kg ha^{-1}) and the maximum days to maturity recorded from low seeding rate (50 kg ha^{-1}) indicating increase in competition to resources with increasing population enhancing earliness in crop plants. Similar findings were reported by Worku (2008) and Jemal *et al*. (2015) who stated that increasing the levels of seeding rate hastened physiological maturity of bread wheat.

The results of analysis of days to maturity due to fertilizer application indicated that short days to maturity recorded from wheat applied with 100 kg ha^{-1} blended fertilizer combined with 23 kg ha^{-1} nitrogen fertilizer. This result was on par with wheat applied with zero blended fertilizer with 23 and 46 kg ha^{-1} nitrogen. The maximum days to maturity was recorded from wheat applied 300 kg ha-1 blended fertilizer with 46 kg ha^{-1} nitrogen. The result also indicated the increase in days to maturity with increase in rate of fertilizer application suggesting increasing application of fertilizer; nitrogen in particular, enhanced vegetative growth of wheat. The fact that nitrogen nutrition is important for synthesis of major macromolecules in plants including proteins, enzymes, pigments, growth-promoting hormones, etc. for maintaining and producing vegetative tissues and cell organelles which in turn contribute to the delay of maturity of plants. The results of current study was in line with reports of Bekalu and Mamo (2016) who stated that, nitrogen fertilization significantly affected days to maturity on wheat. Jemal (2015) observed the maturity of the crop is delayed due to increasing nitrogen fertilizer by affecting the supply of photosynthesis during critical period of the reproductive phase. Diriba (2019) reported that blended fertilizer significantly affected days to heading and maturity.

Plant height (cm)

The analysis of variance indicated that seeding rate and combined blended NPSB with N fertilizer showed significance effect on plant height. But, the interaction of seeding rate and combing blended NPSB with nitrogen fertilizer rates was not significant on plant height (Table 1). The highest plant height (89.1cm) was recorded from 150 kg ha^{-1} seeding rate and the lowest plant height (85.5 cm) was recorded from a seed rate of 50 kg ha^{-1} which was statistically Increase in plant height noticed with increase in seeding rate indicating the theory of competition effect for fixed resources. Similarly, Soomro *et al.* (2009) showed that wheat sown at higher seeding rate (175 kg ha^{-1}) produced high plant height and decrease in plant height low seeding rate. Furthermore, Worku (2008) showed that plant height increased consistently with increasing seeding rate from 72.7 cm at the seeding rate of 100 kg ha^{-1} to 80.4 cm at seeding rate of 150 kg ha^{-1}. High seeding rate resulted change in plant height and stem strength because of inter and intra specific competition for light. Increase in inter node length, reducing stem strength and increasing plant height showed by Otteson *et al*. (2007). Naseri *et al.* (2012) reported highest and lowest plant height records due to the difference in plant densities at 450 and 300 plants m^2, respectively. Height of wheat plants grown at the low seeding rate was significantly lower than the height of wheat plants grown at higher seeding rates (Haile *et al*., 2013; Laghari *et al.*, 2011).

The analysis of variance showed that significantly high plant height (94.5 cm) was recorded from wheat treated with 300 kg ha^{-1} blended NPSB with 46 kg ha^{-1} nitrogen fertilizer. This result was statistically on par with wheat treated 300 kg ha^{-1} blended NPSB with 23 kg ha^{-1} nitrogen fertilizer. The short plant height (76.0 cm) was obtained from wheat treated with zero kg ha^{-1} blended NPSB with 23 kg ha^{-1} nitrogen fertilizer (Table 1). The result indicated increasing plant height with increase in application fertilizer rates. This increment in plant height might be due to increasing supply of nitrogen, phosphorus, sulfur, nutrients during growth and development of wheat plant height. Abedi *et al.* (2011) and Sofonyas (2016) reported significant increments in plant height due to application of nitrogen rate. Similarly, Debnath *et al*. (2011) reported boron application had significant effect on the plant height of wheat. Generally, increased combined application of NPSB with N fertilizer showed consistent increment plant height. Similarly, maximum plant height due to phosphorus fertilizer application was also reported by Baraich *et al*. (2012).

Table 1. Days of heading, physiological maturity and plant height of bread wheat as affected by seeding and blended NPSB and nitrogen fertilizer combined rates at South Ari.

Treatments			
Seeding rate (kg ha^{-1})	**DH (days)**	**DM (days)**	**PH (cm)**
50 SR1	65.6^{a}	110.3^{a}	85.5^{b}
100 SR2	65.3^{a}	107.0^{b}	86.9^{b}
150 SR3	63.4^{b}	103.1^{c}	89.1^{a}
LSD	1.66	0.84	1.91
CV%	3.20	0.98	2.74
Blended NPSB and nitrogen fertilizer combined rates (kg ha^{-1})			
0+23	62.9^{e}	104.7e	76.0^{e}
0+46	62.9^{e}	104.7e	83.8^{d}
100+23	62.9^{e}	104.7e	85.8^{c}
100+46	64.0^{d}	105.7^{d}	86.0^{c}
200+23	65.6^{c}	107.7^{c}	88.6^{b}
200+46	65.8c	108.0^{c}	88.9^{b}
300+23	66.6^{b}	109.0^{b}	93.6^{a}
300+46	67.6^{a}	110.0^{a}	94.5^{a}
Grand mean	64.8	106.79	87.16
$LSD_{(5\%)}$	0.56	0.36	1.67
CV(%)	0.92	0.36	2.02
Interaction	**NS**	**NS**	**NS**

Note: Means with the same letters within the same columns are not significantly different at $P \leq 0.05$ probability level

3.2 Yield and yield component analysis

Number of tiller per plant (NTPP)

Yield of a crop affected due to production efficiency of yield contribution traits of a crop. Analysis of variance showed that both seeding and blended NPSB and nitrogen fertilizer combined rate significantly ($p \leq 0.05$) affected the number of tillers per plant of bread wheat (Table 2). The interaction between the factors was not significant. The maximum number of tillers (7.4) was obtained from 150 kg ha^{-1} seeding rate and the minimum (6.6) was obtained from 50 kg ha^{-1} seeding rate. This increase in the number of wheat tiller production due to increasing sowing density indicated that competition and crowding within the plot area towards resource was not created and the population per unit area might be below the carrying the capacity of the plot. The findings agreed with Iqbal *et al.* (2010) who stated that more number of tillers 503m^{-2} was observed at seeding rate of 175 kg ha^{-1} while less number of total tillers 404 m^{-2} was recorded at seeding rate of 125 kg ha^{-1}. Increase in number of tillers per unit area with increased seeding rate also supported by Ahmad *et al.* (2000), Hussain and Shah (2002) and Naeem (2001).

Blended NPSB and nitrogen fertilizer combined rate analysis revealed that maximum number of tillers (8.5) was recorded from application of 300 kg ha^{-1} blended NPSB with 46 kg ha^{-1} nitrogen fertilizer rate. This result was statistically on par with the number of tillers produced per plant from application of 300 kg ha^{-1} blended NPSB with 23 kg ha^{-1} nitrogen fertilizer rate. The result also indicated that the number of tiller produced per plant was quite not significant for the levels of nitrogen fertilizer applied. But the minimum number of tillers per plant (4.8) was recorded from no blended NPSB fertilizer applied with 23 kg ha^{-1} level of N. The result could be attributed with the application of fertilizers particularly nitrogen blended fertilizer, synergetic roles of the nutrients contained in blended fertilizer enhanced plant vegetative growth and development of the wheat crop. This result was in agreement with the findings of Bereket *et al.* (2014) and Abdollahi (2012) who reported that nitrogen fertilization significant affected production of effective number of tillers production of wheat. Frehiwot (2014) showed potential role N and P fertilizer application in number of total and effective tiller production per plant. Applications of blended fertilizers (NPS+ZnB) resulted significantly higher number of total and effective tillers of wheat when compared to DAP and Urea fertilizers alone (Hailu, 2014).

Table 2. Number of tiller per plant (NTPP), above ground biomass (BM) and thousand seed weight (TSW) of bread wheat as affected by seeding and combined blended NPSB with nitrogen fertilizer rates at South Ari.

Treatments			
Seed rate(kg ha^{-1})	**NTPP**	**BM (kg ha^{-1})**	**TSW(g)**
50	6.57^{b}	10281^{c}	45.16^{a}
100	6.88^{b}	10757^{b}	42.91^{b}
150	7.35^{a}	11863^{a}	42.327^{b}
LSD	0.3	467.78	1.39
CV(%)	5.9	5.32	4.01
Combined fertilizer rates (Kg ha^{-1})			
0+23	4.76^{f}	8529^{g}	42.08^{d}
0+46	5.78^{e}	8796^{g}	41.80^{d}
100+23	6.78^{d}	9145f	42.60^{d}
100+46	6.85^{d}	9809^{e}	43.60^{c}
200+23	7.16^{c}	10750^{d}	43.93^{bc}
200+46	7.46^{b}	12167^{c}	44.05^{abc}
300+23	8.23^{a}	13518^{b}	44.68^{ab}
300+46	8.46^{a}	15022^{a}	44.87^{a}
Grand mean	6.9	10967	43.46
LSD$_{(5\%)}$	0.2	296.92	0.85
CV(%)	4.0	2.84	2.07
Interaction	Ns	Ns	Ns

Thousand seed weight

Seeding rate of wheat and blended NPSB with nitrogen fertilizer combined rates showed significant effect on thousand seed weight. The interaction of seeding rate and blended with nitrogen fertilizer rate did not show significant influence on thousand seed weight of bread wheat (Table 2). The highest thousand seed weight (45.2 g) was recorded for seed sown at 50 kg ha^{-1} whereas the lowest thousand seed weight (42.3g) was recorded at 150 kg ha^{-1}. This result was statistically on par with thousand seed weight recorded at 100 kg ha^{-1}. The result indicated decrease in seed weight with increasing density per unit area of land.

Blended NPSB and nitrogen fertilizer combined rate similarly showed significant effect thousand seed weight of wheat (Table 2). The maximum thousand kernels weight (44.9 g) and the minimum (42.1 g) thousand kernels weight were recorded for the application of 300 kg ha^{-1} of blended NPSB and 46 kg ha^{-1} nitrogen and zero blended and 23kg ha^{-1} nitrogen fertilizer rates, respectively. The result indicated increase in thousand seed weight with increasing rates of blended NPSB and nitrogen fertilizer suggesting the contribution of balanced nutrition in seed weight production. Muhammad *et al.* (2009) reported that applying micronutrients (Zn, B) and macro nutrient with rates of nitrogen showed a positive impact on yield component of wheat crop especially on1000 kernels weight. Abedi *et al.* (2011) also indicated number seeds $spike^{-1}$ and 1000 kernels were significantly enhanced by increasing nitrogen levels. High seed weight is a reflection of improved nutrient use efficiency as a result of increased application of nitrogen level and blended fertilizer, respectively.

Above ground biomass (BM)

Seeding rate and application of blended NPSB and N fertilizer combined rates showed significant effect on the above ground biomass yield. The interaction of seeding rate and blended NPSB and nitrogen fertilizer combined rate was not significant on above ground biomass yield of wheat (Table 2). Highest above ground biomass yield (11863 kg ha^{-1}) was recorded at 150 kg ha^{-1} seeding rate and the lowest (10281 kg ha^{-1}) was obtained at the seeding rate of 50 kg ha^{-1}. The result indicated increasing biomass production along with wheat seeding rate suggesting the plant population below the carrying capacity of the plot that would result on resource competition. The present result is in agreement with the finding of Zewdie *et al.* (2014) who reported appositive association between biomass yield and plant height that resulted in higher biomass yield. Jemal *et al*. (2015) also reported that high biomass yield production was recorded on increased seeding rates of 200 and 175kgha^{-1}.

Blended NPSB and nitrogen fertilizer combined rates also had shown a significant effect on above ground biomass yield of wheat (Table 2). Maximum biomass yield (15022 kg ha^{-1}) was recorded at 300 blended NPSB and 46 kg ha^{-1} nitrogen fertilizer combined application rate and the minimum (8529 kg ha^{-1}) was recorded at zero blended and 23 kg ha^{-1} nitrogen fertilizer rates. This result was on par with the amount of above ground biomass yield measured when applying zero blended and 46 kg ha^{-1} nitrogen combined rate. Wheat plants grown under maximum blended and nitrogen fertilizer application increased above ground dry biomass yield by 43.3% over the treatments received no blended and 23 kg ha^{-1} nitrogen combined fertilizer rate. The result suggested supply of nitrogen along with nutrients in blended fertilizer enhanced photosynthetic activity, vegetative growth, chlorophyll formation and resulted increased biomass production. Enhanced photosynthetic assimilation of nitrogen in crop plants due to sulfur was reported by Abdin (2000). The supply of phosphorus favored tiller production which further increased biomass yield through proper regulation of carbohydrates translocation. In agreement with this finding, Fayera *et al*. (2014) and Shiferaw (2012) reported that application of blended fertilizer significantly influenced above ground dry biomass yield of wheat.

Table 2. Number of tiller per plant, above ground biomass and thousand seed weight of bread wheat as affected by seeding and combined blended NPSB with nitrogen fertilizer rates at South Ari.

Treatments			
Seed rate(kg ha^{-1})	**NTPP**	**BM (kg ha^{-1})**	**TSW(g)**
50	7.4^{a}	10281^{c}	45.2^{a}
100	6.9^{b}	10757^{b}	42.9^{b}
150	6.6^{b}	11863^{a}	42.3^{b}
LSD$_{(5\%)}$	0.3	467.78	1.39
CV(%)	5.9	5.32	4.01
Blended NPSB and nitrogen fertilizer combined rates (kg ha^{-1})			
0+23	4.8^{f}	8503^{g}	41.9^{d}
0+46	5.8^{e}	8796^{g}	41.9^{d}
100+23	6.8^{d}	9145f	42.6^{d}
100+46	6.9^{d}	9809^{e}	43.6^{c}
200+23	7.2^{c}	10750^{d}	43.9^{bc}
200+46	7.5^{b}	12167^{c}	44.1^{abc}
300+23	8.2^{a}	13518^{b}	44.7^{ab}
300+46	8.5^{a}	15022^{a}	44.9^{a}
Grand mean	6.9	10967	43.5
LSD$_{(5\%)}$	0.2	294.4	0.9
CV$_{(\%)}$	4.0	2.8	2.1
Interaction	Ns	Ns	Ns

Note: Means with the same letters within the same columns are not significantly different at $P \leq 0.05$.

Grain yield

Grain yield as significantly effect by the interaction of seeding rate and blended NPSB and nitrogen fertilizer combined rate is presented in Table 3. The highest grain yield (7407.4 kg ha-^{1}) was obtained at 150 kg ha^{-1} seeding rate and application of 300 kg ha^{-1} blended NPSB with 46 kg ha^{-1}N whereas the lowest grain yield (3388.8 kg ha^{-1}) was obtained at 50 kg ha^{-1} seeding rate and zero blended with 23 kg ha^{-1} fertilizer combined application rate. The present study result showed increase in grain yield and advantage of wheat production with increasing seeding and rates of blended NPSB and nitrogen fertilizer combined rate. The result also indicated the cumulative effect of increasing seeding rate and blended NPSB with nitrogen fertilizer combined rate effect on plant height, number of tillers and above ground biomass yield. Hussain and Shah (2002) and Worku (2008) also showed grain yield increase as seeding rate was increased from 50 to 150 kg ha^{-1}. Similarly, Seleiman *et al*. (2010) confirmed that increased grain yield with increasing seeding rates up to 400 grains m^{-2}. Increasing rate of nitrogen fertilization increased grain yield of wheat was documented by Bereket *et al*. (2014). Furthermore, Mulugeta *et al*. (2017) reported that application of K, S, Zn, Mg and B nutrients significantly increased grain yield and yield component of bread wheat.

Harvest index

Efficiency of resources utilization of a crop or the relationship of economic yield to the total or biological yield is expressed with harvest index value as coefficient of effectiveness. Thus, effectiveness of wheat under different seeding rate and blended NPSB with nitrogen fertilizer combined rate was analyzed and presented in Table 3. The results of analysis indicated that the factors interaction significantly affected harvest index.

The highest harvest index (47.1 %) was recorded seeding at 100 kg ha^{-1} and applying combined fertilizer rate of zero blended NPSB with 23 kg ha^{-1} nitrogen and the lowest harvest index (37.6 %) was recorded at 50 kg ha^{-1} seeding and combined fertilizer rate of 300 kg ha^{-1} NPSB with 46 kg ha^{-1} nitrogen application (Table 3). The low harvest index recorded from lowest seeding and high combined fertilizer rates. The result indicated neither increasing seeding rate nor fertilizer improved coefficient of effectiveness of wheat. Similar with the present finding Iqbal *et al.* (2010) stated that highest harvest index obtained at seeding rate of 150 kg ha^{-1} as compared to 125 and 175 kg ha^{-1}. The result also showed the high combined fertilizer rate didn't increased harvest index suggesting fertilizer application favored only biomass production. In line with this result, Woyema *et al.* (2012) reported highest harvest index of wheat recorded from wheat treated with low rate of nitrogen. Jemal (2015) also showed reduction of harvest index in cereal crops resulted during excess nutrient application.

Table 3. Grain yield and harvest index of bread wheat as affected by the interaction of seeding and blended NPSB and nitrogen fertilizer combined rates at South Ari.

Seeding rate(kg ha^{-1})	**Blended NPSB and nitrogen fertilizer combined rates (kg ha^{-1})**	**Grain Yield (Kg /ha)**	**HI**
50	0+23	3388.8^{p}	42.7
50	0+46	3425.9^{P}	42.2
50	100+23	3509.2^{o}	41.2
50	100+46	3620.3^{n}	39.4
50	200+23	3999.9^{m}	39.3
50	200+46	4472.2^{j}	39.2
50	300+23	4861.1^{h}	38.6
50	300+46	5314.7^{g}	37.6
100	0+23	3962.9^{m}	47.1
100	0+46	4018.5^{m}	46.7
100	100+23	4129.6^{l}	45.5
100	100+46	4249.9^{k}	43.6
100	200+23	4703.7^{i}	43.5
100	200+46	5249.9^{g}	43.4
100	300+23	5759.2^{e}	42.8
100	300+46	6296.2^{c}	41.6
150	0+23	3944.4^{m}	43.3
150	0+46	3981.4^{m}	41.6
150	100+23	4351.8^{k}	45.3
150	100+46	4935.1^{h}	45.6
150	200+23	5472.2^{f}	45.5
150	200+46	6120.3^{d}	45.5
150	300+23	6722.2^{b}	44.9
150	300+46	7407.4^{a}	44.0
Mean		4745.7	42.9
CV (%)		1.04	1.4
SEm (±)		28.5	0.4

4. Conclusion

The study of seeding rate and blended NPSB with nitrogen fertilizer combined rates significantly affected wheat phenology, growth, yield and components. The result indicated increasing rates of seeding and blended NPSB with nitrogen fertilizers combined rates increased wheat phenology, growth, yield and yield components of wheat, except harvest index where neither increasing seeding nor combined fertilizer rates resulted in high harvest index. Therefore, it is concluded that application 100 kg ha^{-1} seeding rate and no blended NPSB combined with 23 kg ha^{-1} nitrogen fertilizer and or 150 kg ha^{-1} seeding rate and 200 kg ha^{-1} blended NPSB with 23 kg ha^{-1} combined rate found to be significant to impact wheat growth and yield at South Ari.

Data Availability

The data used to support the results of this study are included within the manuscript, and any further information is available from the corresponding author upon request

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