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Effect of blended NPS fertilizer on food barley varieties in Gurawa district Ethiopia

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Abstract
Food barley is one of the major staple crops in Ethiopia. In Gurawa district, the productivity of food barley is low due to poor agronomic practice. Most of the farmers in these areas do not use fertilizer and few others use very much below the optimum rate and inappropriate NPS fertilizer applications rate are among the most important agronomic factors that hinders productivity of food barley around the study area. An experiment was conducted in the Gurawa district in 2020 main cropping season to examine the responses of different NPS fertilizer rates on yield and yield components of food barley. Five different NPS fertilizer rates (0,50, 100, 150 and 200 kg ha^{-1}) and three barley varieties (EH1493, BH1307 and Cross#41/98) a total of 15 treatment combinations were laid out in randomized complete block design with three replications. Phenological, growth, yield and yield related data were collected and analyzed using gestate software. The results of this study indicated that the main effect of different varieties and application of different NPS fertilizer rates showed highly significant effect on yield and yield components of food barley. However, the interaction effects of varieties and NPS rates did not significantly affect grain yield and yield components of food barley. The application of 200 kg ha^{-1} NPS fertilizer rate was gave the highest grain yield (4592 kg ha^{-1}) compared with the other rates of NPS fertilizer application. The results of the partial budget analysis indicated that the application of 200 kg ha^{-1} of NPS fertilizer rate resulted in maximum marginal rate of return (1042.47%) and are economically profitable with a net benefit of 134798 birr ha^{-1} compared to other treatments. Thus it can be concluded that application of 200 kg NPS ha^{-1} was found to be profitable both agronomical and economical and can be recommended around the Gurawa area.

Keywords: Grain yield, food barley, fertilizer rate, economically profitable, varieties

Introduction

Barley (*Hordeum vulgare* L.) is an important grain crop in Ethiopia and has diverse ecologies being grown from1800 to 3400m altitude in different seasons (Muluken, 2013) [39] and makes Ethiopia being the second-largest producer in Africa, next to Morocco, accounting for about 25% of the total barley production in the continent (FAO, 2014) [16] According to the 2014/2015 forecasts from Ethiopia's Central Statistics Authority, of the 12.6 million hectares under cultivation of the grain crops, 80.78% was under cereals which contributed 87.36% of the grain production and barley took up about 8 and 7 percent of the grain crop area, and production respectively (CSA,2014/2015) [11].

In Ethiopia barley is ranked fifth of all cereals, based on the area of production, but third based on yield per unit area. It covers 7.56% of the land under grain crop cultivation with a yield of 1.96t ha^{-1} (CSA, 2016) [12]. Whereas the potential yield goes up to 6 t/ha on experimental plots (Habtamu *et al*, 2014) [19] indicating a productivity gap of about 4 tons per ha. Filling this gap would make Ethiopia among the major barley producing countries. Food barley is a fourth important crop in eastern Hararge followed by maize, sorghum and wheat in terms of the number of households (101,994) producing and fifth important crop in terms of area coverage (6,431.46 ha) followed by sorghum, maize, wheat and teff. However, the productivity of food barley in eastern Hararge is low 20.29 quintal/ha compared to the regional average of Oromia 21.73 quintal/ha (CSA, 2013/14). So far, no efforts have been made in promoting newly released food barley in eastern Hararge even though there is great potential in the highlands of the zone.

There are several factors that reduce yield of barley in Ethiopia. They are poor soil fertility, water logging, drought, frost, soil acidity, diseases and insects, and weed competition (ICARDA, 2008) [20]. Among these, the most important constraints that threaten barley production in Ethiopia are poor soil fertility and low pH.

Since the major barley producing areas of the country are mainly located in the highlands, severe soil erosion and lack of appropriate soil conservation practices in the past have resulted in soils with low fertility and pH which leads to reduce barley production in Ethiopia.

Consequently, the addition of nutrients like N, P and S to low fertile soil is important to increase barely yield and yield components. A balanced supply of essential nutrients needs for the growth of crops and optimal productivity. Lack of supply of mineral elements may limit plant growth and development (Nadian *et al.*, 2010) [26]. Improved varieties (high yield, disease resistant, drought-resistant), good cultural practices like balanced fertilization and other management are very important for higher productivity of barely. Variety based fertilizer and soil fertility status recommendations are unusual in Ethiopia. Barely is very sensitive to insufficient nitrogen and very responsive to nitrogen, however, nitrogen is commonly the most limiting nutrient for crop production in the major agricultural areas and therefore adoption of good N management strategies often results in large economic benefits to farmers. Among the plant nutrients, it plays a very important role in crop productivity (Oikeh *et al*., 2007; Worku *et al*., 2007) [27, 35].

Adequate phosphorus nutrition enhances many aspects of plant physiology, including the fundamental processes of photosynthesis, root growth particularly the development of lateral roots and fibrous rootlets (Brady and Weil, 2002) [8].

Balanced fertilization is the key to sustainable crop production and maintenance of soil health. For the last four to five decades, Ethiopian agriculture depended on imported fertilizer products; only urea and Di-ammonium phosphate (DAP), as sources of N and P, respectively. However, currently, it is generally recognized that the production of cereal crops can be limited by the deficiency of S and other nutrients (Assefa *et al*., 2015) [4]. The investment in inorganic fertilizer for crop production must be profitable to a farmer to justify its continuous use. Furthermore, a blanket recommendation often leads up to some nutrients being wasted like S. Although there are few studies on the economic benefits of fertilizer use in SSA, the results shows positive returns on inorganic fertilizer investments when either applied solely or in combination with organic amendments. (Vanlauwe *et al*., 2011) [32].

According to agricultural transformation agency (ATA) (2017), the blanket recommendation fertilizer for the barley was 100 and 150 kg ha^{-1} DAP and Urea respectively in the Arsi zone. However, the national recommendation of Urea and DAP (Di-ammonium Phosphate) were100 kg ha^{-1}, which farmers in most parts of Ethiopia including eastern Ethiopia are using without considering the differences of soil types and fertility status (MOA, 2013). This fertilizer only contains nitrogen and phosphorus that may not sufficient for the nutrient requirements of crops, which reduces yield and yield components of barley in Ethiopia. In order to solve these problems, the Ministry of Agriculture of Ethiopia has been currently introduced a new inorganic fertilizer (NPS) containing nitrogen, phosphorus and sulphur with a ratio of 19% N, 38% P_2O_5 and 7% S as the main source of phosphorous (MoANR, 2013).

Only 30 to 40% of Ethiopian smallholder farmers use fertilizer, and those that do only apply 37 to 40 kg on average per hectare, which is below the recommended rates (MoA, 2012). Gurawa where this study was conducted is one of barley producing area in east Hararge zone of eastern Oromia, Ethiopia. The production of barley in the area under main cropping season is well known; since there is a high demand grain for food, sell and straw for animal feeds. Barley yield is low in Eastern Hararge and Gurawa districts because most of the farmers in these areas do not use fertilizer and few others use very much below the optimum rate (Gurawa agriculture and natural resource office, 2019). Therefore, in the area there is a need to study the effect of different NPS rates on the yield and yield components of barley to achieve maximum yield. The objective of this study was to assess the effect of NPS fertilizer rates on yield and yield-related traits of barley varieties and to estimate the cost-benefit of NPS fertilizer rates for barley production.

Materials and Methods

Description of the Study Areas

Field experiment was conducted at experimental site of Haramaya University in Gurawa district in East Hararge zone of Oromia regional State, Ethiopia, during 2020 main cropping season. The altitude of this district ranges from 500 to 2425 meters above sea level and the latitude $09^0$08'12.8" N and longitude 41°51'09.3" E. The rainfall pattern is bimodal, the first rains (Belg) fall starting from March/April to May and the main rain season extends from June to September/October with an average annual rainfall of 725 mm.

Design, Treatments and Procedures

The experiment consisted of 15 treatments, five NPS fertilizer rates (0, 50, 100, 150 and 200 kg ha^{-1} and three barley varieties (EH1493, HB1307 and Cross 41/98), besides 100 kg ha^{-1} of Urea was applied uniformly to all plots. The experiment was arranged in factorial combination of randomized complete block design (RCBD) with three replications and consisted of five fertilizer rates: (T1) NPS (0 kg h^{-1}) used as a control, (T2) NPS (50 kg h^{-1}), (T3) NPS (100 kg h^{-1}), (T4) NPS (150 kg h^{-1}), (T5) NPS (200 kg h^{-1}) and three food barley varieties (EH1493, HB1307 and Cross41/98). The total treatment were combined of 5 x 3 = 15. Gross plots size was 2m x 2m = $4m^2$) and the distance between plots and blocks were 0.5 m and 1m apart, respectively. Each plot consisted of 10 rows and the spacing between barley plant rows was 20 cm apart.

The land of experimental field was ploughed three times and prepared very well before time of sowing and by using tractor and ploughing. The first was tilled by tractor, the second was tilled by oxen and the third was plowed and leveled manually. The layout of experimental field was made and the plots were leveled across a gradient slop of land and the full rate of NPS was drilled based on the treatments in the rows and incorporated with the soil at sowing the seed. The rows were made across each plot and treatments were assigned randomly to distribute the experimental plots in the blocks, seed was drilled by hand at the seed rate of 125 kg h^{-1} (50 gm $plot^{-1}$). The urea was applied in two splits application after planting (50% was applied at 45 days after emergence and half was top dressed at the tillering stage).

Soil Sampling and Analysis

Before planting 12 soil samples were collected from 0-30 cm depth in zigzag way from the experimental field and composited as one soil sample and were taken to the soil laboratory and the samples were air-dried, grind and sieved through a 2mm sieve tube and analyzed for selected soil parameters such as, soil PH, cation exchange (CEC), organic carbon, total N, available P, S and soil texture at Haramaya university Agricultural research laboratory Soil texture was determined using the Bouyoucos hydrometer method (Bouyoucos, 1962) [7]. The pH of the soil was measured in the supernatant suspension of a 1: 2.5 soil to water ratio using a pH meter by potentiometer method (Rhoades, 1982) [40]. Organic carbon was determined by Walkley and Black oxidation method (Walkley and Black, 1934) [41]. Cation exchange capacity and Exchangeable K was measured after saturating the soil with 1N ammonium acetate (NH4OAC) and displacing it with 1N NaOAC (Van Reeuwijk, 1993) [42]. Available phosphorus was determined using the Olsen method (Olsen *et al*., 1954) [43]. Available S was determined by KH2PO4 extractant (Johnson and Fixen, 1990) [44]. Available B was determined using hot water method (Sippola and Ervio, 1977) [45].

Data collection

Crop phenology: days to 50% heading, days to 90% physiological maturity

Growth and yield parameter: plant height (cm), spike length (cm),number of productive tillers, total number of tillers, number of seed per spike, thousand grain weights, grain yield, aboveground dry biomass yield, straw yield, harvest index

Data Analysis

The collected data were subjected to statistical analysis. Analysis of variance (ANOVA) was carried out using genstat software. The comparisons among treatment means were assessed using the least significant difference (LSD) test at 0.05 level of probability (Gomez and Gomez, 1984) [18].

Results and Discussion

Chemical and Physical Properties of Soil before Sowing

The physical and chemical properties of the soil of the study area were conducted at the soil laboratory of Haramaya University main campus. The result of soil analysis in the laboratory was indicated that the soil texture of the experimental area was dominated by (sandy clay loam).The ratio of soil texture (proportion of sand, silt and clay, in the soil) of experimental field was 52%, 26% and 22% sand, silt and clay, respectively. The texture properties of the soil influence water holding capacity, water intake rates, aeration, root penetration and soil fertility.

Table 3: chemical and physical property of soil in the study area

Physical properties	Content	Rating
Soil texture		
Sand (%)	52	High
Silt (%)	26	Moderate
Clay (%)	22	Moderate
Textural class		sandy clay loam
Chemical properties		
PH(1:2.5)	6.02	Slightly acidic
Organic carbon (%)	0.914	Low
Total nitrogen (%)	0.14	Low
Available p(mg/kg)	8.2	High
CEC Cmol+/kg of soil	37	High

Crop Phenology and Plant Height

Days to 50% heading and 90% physiological maturity

Data analysis of variance showed that the main effect of varieties and NPS were highly significant (*p*<001) on plant height, 50% heading and 90% physiological maturity but their interaction did not significantly affect 50% of heading and 90% physiological maturity. The mean number of days required to 50% heading was between 58.87 and 75.20 days for the varieties (Table 3). The fastest day to heading was recorded for Cross41/98, while the longest day to heading was recorded for EH1493 (Table 3).

The number of days required to 90% physiological maturity was between 107.9 and 123.8 days for the varieties (Table 3). The earliest day to maturity was recorded for Cross#41/98 and the longest days to maturity was recorded for EH1493. Similar to the days to 50% heading the interaction effect of fertilizer treatments and varieties (Table 3) did not show significant effect on days to physiological maturity. The significant difference among the varieties for these phonological traits might be due to their genetic inheritance variation. The maximum days of heading were observed with 0 NPS kg/ha while the minimum days of heading were observed with 200 NPS kg/ha, which might be due to the composition NPS contains p which was used in the plants cell by dray matter accumulation which facilitates plant growth and development, therefore it fastens the period of crop maturity. This finding was consistence with (Abebe, 2018; Lake and Bezabih, 2018) [1, 22].

According to the current study the longest day to maturity was recorded from the control and the shortest days to maturity was observed from the plots which received highest NPS fertilizer rate (Table 3). As NPS fertilizer rate increased days to maturity was decreased, due to phosphorus plays a vital role in the development of the reproductive part of plants, seed formation, root growth and encouragement of early maturing of crops (Brady and Weil, 2002) [8]. This result was consistence with Chalachew (2019) [10], who reported that days to maturity of food barley was shorter at higher rates of NPS application and Tagesse Abera *et al.* (2018) [31] reported that days to maturity of bread wheat was shorter at higher rates of NPS fertilizer application. Besides that the application of NPS fertilizer and compost at higher rates gave early maturity because of vigorous growth, early tasseling and silking of the crop, while plants at the lower nutrient application matured lately because of insufficient nutrients (Sisay and Adugnaw, 2020). This finding was also supported by Dagne (2016) [13] who describes early maturity days were recorded with the application of blended fertilizer whereas the longest days to maturity were recorded for control.

Plant height

Data analysis of variance showed that the main effect of varieties and NPS were highly significant (*p*<001) on plant height. The tallest plant height (106.79 cm) was obtained from the varieties EH1493 and shortest plant height (86.70 cm) was obtained from the varieties Cross #41/98 which might be due to genetic inheritance differences between varieties. This finding was consistence with (Abebe, 2018; Lake and Bezabih, 2018) [1, 22]. The plant height was also increased with increasing blended NPS fertilizer application. The tallest plant height was recorded from the plots which received 200 kg h^{-1} while the shortest was observed from plots which received 0 kg h^{-1}. Besides the application of phosphorus slightly increases plant height. This result was supported by (Mesfin Kassa, *et al*., 2015) [24], similar with (Tagesse Abera *et al*., 2018) [31].

Spike length

The main effect of varieties and NPS had highly significant effect (*p*<0.001) on spike length. But the interaction of blended NPS and varieties did not significantly affect spike length. The longest spike length (12.17 cm) was obtained from the plots which received 200 NPS kg h^{-1} then, the shortest (9.4) was recorded from 0 NPS kg h^{-1} nitrogen and phosphors increases vegetative growth of plants. Besides, the spike length was significantly increased with increasing application of blended fertilizer rates (Table 3) In line with the finding of Diriba *et al.* (2019) [14] who reported that NPSB rate applications increased spike length of bread wheat. Similarly, Dinka Tariku *et al*. (2018) [47] reported that higher mean spike length of barley was obtained from application of sole and integrated nutrient management as compared to non-fertilized on barley. Similarly Wakene *et al.* (2014) reported that plant height of barely was increase with increased NP fertilizer rates application.

Table 4: The main effect of varieties and blended NPS fertilizers on phenology, spike length and plant height

Treatments NPS kg ha^{-1}	DH (50%)	DM (50%)	Plant height (cm)	Spike length (cm)
0	73.11a	126.1a	87.31a	9.4a
50	66.33^{b}	117.8b	97.59b	12.05b
100	66.11b	115c	99.65b	12.49bc
150	64.78b	113.6c	102.01b	13.14c
200	64.56b	111.3d	107.79c	14.17d
Varieties				
EH1493	75.20a	123.8a	106.79c	13.10c
HB13O7	66.87b	118.5b	103.12b	12.68b
Cross#41/98	58.87a	107.9c	86.70a	11.00a
Varieties	**	*	*	*
Fertilizer	*	*	*	*
Fertilizer*Varieties	Ns	Ns	ns	ns
CV%	2.9	1.7	3.6	4.2
LSD%	1.424	1.89	3.4	0.49

LSD=least significant difference; CV=coefficient of variation; DH= days to heading, DM=days to maturity

Yield and Yield related parameters

Number of seed/spike

The main effect of NPS fertilizer rates had highly significant influence (*p*<0.01) on number of seed/spike of barley. However varieties had significant influence on number of seed per spike (*p*<0.05) and the maximum and minimum number of seed per spike was recorded from varieties EH1493 and Cross41/98, respectively. This result was due to genetic variation between varieties and it was similar with the finding of (Alam *et al*., 2007) [46]. The maximum (60.87) number of seed per spike was recorded from the plots which received 200 kg h^{-1} while; the minimum (40.83) was obtained from control plots. The incensement of number of seed per spike linearly increases with the application of blended NPS fertilizer rates (Table 4). This result is consistence with the finding of Malkamu *et al.* (2019), who evaluated the response of different blended fertilizers on yield and yield components of food barley and in line with Bereket *et al*. (2014) [6] who reported that macro and micro nutrients (Nitrogen, Phosphorous with Sulfur and Born) fertilizers application can increase plant height, spike length, number of tillers and number of kernel with increasing doses and combination.

Number of total tiller

The analysis of variance was noticeable that the application NPS fertilizers and varieties had highly significant influence (*p*<0.001) on number of total tillers per plant. But, their interaction effect of the two factors was not significant. The highest number of total tillers (6.08 tiller/plant) was obtained with the application of blended fertilizer 200 kg NPS ha^{-1}, while the lowest number of total tillers (3.84 tiller/plant) was obtained from the unfertilized plots (Table 4). The number of tillers was increased with the highest rates of NPS might be due to the rapid exchange of combined carbohydrates into protein and accordingly increased the number and size of growing cells, finally leading in increased number of tillers. This finding is in line with the result of (Yared Tesfaye *et al*., 2020) [37].who concluded that combined application of 150 kg NPS and 46 kg N ha^{-1} can be recommended for production of teff in the study area and other areas with similar agro-ecological conditions. In agreement with the result, Wakjira (2018) reported total number of tillers increased consistently and significantly in response to increasing the rate of blended NPS fertilizer from nil to 120 kg ha^{-1}. Seifu (2018) [48] reported that highest total number of tillers of teff was obtained from the application of the highest rate 150 kg ha^{-1} blended (NPSB) fertilizer whereas the lowest number of tillers was from the control plot.

Thousand grain weight

The thousand grain weights were not significantly affected by varieties and their interaction with fertilizers, but highly significantly affected (*p*<001) by NPS fertilizer application. The highest thousand grain weight (49.90 gm) was attributed from the plots which received 200 NPS kg ha^{-1} and the lowest (43.64) was recorded from unfertilized plots (table 4).This result was in line with the findings of Malkamu *et al.* (2019), who evaluated the response of different blended fertilizers on yield and yield components of food barley and who obtained the maximum (43.97 gm) 1000 kernels weight were obtained from the application of 200 NPSB kg ha^{-1} blended fertilizers treatment. Whereas, thousand kernel weight (28.37 gm) t was obtained from the control. Correspondence with the finding of Assefa Woldie (2015) [5] who suggested that increasing incorporated cattle manure and mineral fertilizer application had increased the thousand kernel weights of barley.

Productive tiller

Data analysis of variance showed that the main effect of varieties and NPS had significant influence (*p*<001) on productive tiller. Number of productive tiller per plant of barley was increased with increasing blended fertilizers application rates. The maximum productive tiller (5.310) was observed from the highest NPS fertilizer application rate and the minimum (2.67) was obtained from unfertilized (control) plot. (Table 5). The highest number of productive tillers might be due to sufficient amount of growth and development of plants owing to the essential elements under blended NPS fertilizer condition. This result was consistence with the results of Fayera *et al*. (2014) [17], who found the highest productive tillers of teff (26 tillers per plant) under the application of 200 kg ha^{-1} of blended fertilizer (14N, 21P_2O_5, 15K_2O, 6.5S, 1.3Zn and 0.5B) combined with 23 kg N ha^{-1} fertilizer. This result is also supported by the findings of Wakjira (2018), where productive tiller number of teff was increased from 8.62 to 15.17 under the application blended NPS fertilizer rates at zero and 120 kg ha^{-1} respectively. Similarly, Seifu (2018) [48] reported that highest number of productive tillers of teff was obtained from the application of the 150 kg ha^{-1} blended (NPSB) fertilizer rate while the lowest number of productive tillers obtained from the control plot.

Grain yield

The analysis of variance described that the main effect of varieties had highly significant (*p*<0.001) effect on grain yield of barley however NPS fertilizer application rates had significant effect (*p*<001) on grain yield. But the interaction of NPS and Varieties were not significant effect on the grain yield (Table 4). Increasing the rates of NPS fertilizers was increased the grain yields of barley. The maximum grain yield (4.592 t ha^{-1}) was obtained from 200NPS kg ha^{-1} of fertilizer application. Oppositely, the minimum grain yield (2.625 t ha^{-1}) was gained from unfertilized plot, The maximum grain yield at the highest NPS rate of fertilizer might have resulted from more profitable root growth and increased uptake of nutrients and better growth preferred over all others due to working together/collaborative effect of the three nutrients which enhanced yield components and yield of barley. This result was in line with the finding of Yared *et al*. (2020) [37] who illuminate the effects of blended NPS fertilizer rates and row spacing on yield and yield components of barley at highlands of Ethiopia.

Aboveground biomass

Data analysis was revealed that the main effect of varieties and NPS were highly significant (*p*<001) on above ground biomass. However, their interaction was not significant on above ground biomass. The maximum total above ground biomass (12337 kg h^{-1}) was observed from the plots which received the highest (200 kg h^{-1} NPS) fertilizer rates and the minimum biomass (7132 kg h^{-1}) was obtained from the plot which received the lowest (0 kg h^{-1} NPS) fertilizer rates (Table 4). As NPS increased the total biomass was also increased. This might be due to the application of P, N and S increases dry matter accumulation in plant tissues and nitrogen and phosphors increases vegetative growth of plants, especially at higher doses. In addition, the significant increase in spike length, number of seeds per spike, number of fertile tillers, non-fertile tillers and grain yield by NP contributed for the significant increase in TBM. These finding is in line with the result of Mesfin, and Zemach., (2015) who reported the effect of nitrogen and phosphorus fertilizer rates on yield and yield components of barley and supported by Rashid.*et.al*. (2007) [28] who indicated comparative effect of varieties and fertilizer levels on barley.

Straw yield

The analysis of variance indicated that the main effect of NPS fertilizer rates and varieties had highly significant effect (*p*<0.001) on the straw yield of barley. The highest (7.745 t ha^{-1}) and the lowest (4.507 t ha^{-1}) straw yield were obtained from application of 200NPS kg ha^{-1} of blended fertilizer and unfertilized respectively. The straw yield increases with increasing NPS fertilizers rates due to phosphorus which increases dry matter accumulation (Table4). These result was consistence with the finding of Wubishet *et al*. (2017) [49] who reported that application of 150 kg ha^{-1} NPSB blended fertilizer increased the straw yield and agreement with the finding of Yared *et al*. (2020) [37], who reported effect of blended NPS and nitrogen fertilizers rates on yield components and yield of tef [eragrostis tef (zucc.).

Table 5: The main effect of Varieties and NPS fertilizer rates on yield and yield related component of barley

Treatments	Spike length	Straw yield	Grain yield	Above ground	Total tiller/p	Productive tiller/plat	Number of seed/	Thousad grain
0	9.4a	4507^{a}	2625^{a}	7132^{a}	3.84	2.67^{a}	40.83	43.64^{a}
50	12.05b	6526^{b}	3305^{b}	9831^{b}	5.066	3.841^{b}	52.82	45.80^{b}
100	12.49bc	6928^{bc}	3971^{c}	10899^{c}	5.458	4.554^{c}	55.18	46.93^{bc}
150	13.14c	7589^{c}	4310^{cd}	11899^{d}	5.736	4.943^{cd}	56.77	48.27^{cd}
200	14.17d	7745^{c}	4592^{d}	12337^{d}	6.08	5.310^{d}	60.87	49.90^{d}
Varieties								
EH1493	13.10^{c}	7800^{c}	3525^{a}	11325^{c}	4.596^{a}	4.145^{a}	54.43^{b}	46.13
HB1307	12.68^{b}	6592^{b}	3968^{b}	10561^{b}	5.319^{b}	3.933^{a}	54.21^{b}	47.20
Cross41/98	11.00^{a}	5584^{a}	3789^{b}	9374^{a}	5.798^{c}	4.711^{b}	51.25^{a}	47.10
Varieties	**	**	**	**	**	*	*	Ns
Fertilizes	**	**	**	**	**	*	**	**

Fertilizers*V	Ns	Ns	Ns	Ns	Ns	Ns	Ns	Ns
Varieties								
CV	4.2	11.9	8.8	6.8	8.7	8.4	5.9	3.1
LSD	0.49	588.9	292.3	681.2	0.43	0.343	3.01	1.321

LSD=least significant difference; CV=coefficient of variations; Ns=no significant

Agronomic use efficiency

The analysis of variance shows that nutrient uptake was significantly different ($p<0.001$) among the varieties. The maximum nutrient uptake (14.70 kg ha^{-1}) was observed from Cross#41/98 variety, whereas the minimum was gained from EH1493 variety (10.07 kg ha^{-1}) (Table 5), which might be due to genetic inheritance deference among varieties. However, the main effect of blended NPS fertilizers was significantly influence ($p<0.05$) on agronomic use efficiency. Besides the utilization of different NPS blended fertilizers rates were significantly affect clearly revealed nutrient return and agronomic use efficiency on barley (Table 5). As the application of NPS fertilizer rates increased, then the clearly revealed nutrient return and agronomic use nutrient efficiency were decreased. Therefore, clearly revealed nutrient return and agronomic nutrient use efficiency was recorded at 100 and 50 Kg ha^{-1} NPS blended fertilizers respectively. This result was consistencies with the finding of Melkamu *et al*. (2019) [23] Who declared effects of blended fertilizers on nutrient use efficiency and the effects of different blended fertilizers and their rates on yield and yield components of barley.

Harvest index

Analysis of variance shows that Harvest index was highly significantly ($p< 0.001$) affected by main effects of blended NPS and varieties and not significantly affected by their interaction. This result is in lined with the findings of Tagesse Abera *et al.* (2018) [31]. Harvest index was linearly increased with increasing fertilizer application. The highest mean harvest index (44.92) was obtained at higher rate of NPS (200 kg ha^{-1}) while, the lowest harvest index was gained from the control plots (0NPS kg ha^{-1}). In the varieties the highest harvest index (47.29%) was observed from Cross#41/98, while the lowest harvest index (34.27%) was obtained from HB1307 (table5). The variety that have most harvest index was visible its tendency to efficiently distribute the dry matter gained to sink organ contrasted to other varieties. This result is followed by (Ketema Niguse *et al*., 2018) [21].

Table 6: The main effect of varieties and NPS fertilizer on harvest index and nutrient uptake

Treatments	Agronomic efficiency	Harvest index%
Fertilizers (kg ha^{-1})		
0NPS	0	30.94
50NPS	13.67	38.35
100NPS	13.47	42.09
150NPS	11.24	44.02
200NPS	9.84	44.92
Varieties EH1493	10.7^{a}	44.64^{c}
HB1307	11.40^{a}	34.27^{a}
Cross#41/98	14.70^{b}	47.29^{b}
Fertilizer	*	**
Varieties	*	**
Fertilizer*Varieties	Ns	Ns
CV%	19.2	6
LSD%	3.529	2.296

LSD=least significant difference; CV=coefficient of variation; au=agronomic use efficiency; HI%=harvest index

Economic Analysis

Partial Budget Analysis: As indicated in Table 6, the highest net benefit of 134798 Birr ha^{-1} with marginal rate of return (MRR) of 1042.47% was obtained in response to application of 200 kg blended NPS ha^{-1} combined with 46 kg N ha^{-1}. However, the lowest net benefit 78750 Birr ha^{-1} was Obtained for the control treatment without the application of NPS fertilizer rates. Thus, applications of 200 kg blended NPS ha^{-1} combined with 100 kg urea ha^{-1} rate is economically beneficial as compared to the other treatments in the study area because the highest net benefit and the marginal rate of return was above the minimum level (100%). In this case 100 kg ha^{-1} of urea was equally applied for all treatments.

Table 7: Economic analysis of barley yield under blended NPS fertilizer rates in district

Treatments	NPS Kg ha^{-1}	Adjusted Yield kg ha^{-1}	Total Return (Birr ha^{-1})	Total variable Cost (Birr ha^{-1})	Net Income (Birr ha^{-1})	MRR (%)
T1	0	2625	78750	0.00	78750	0.00
T2	50	3305	99150	740.5	98410	2654.96
T3	100	3971	119130	1481	117649	0.00
T4	150	4310	129300	2221.5	127078.5	1273.4
T5	200	4592	137760	2962	134798	1042.47

N.B. Price of urea = 14.56 Birr kg^{-1}, Price of NPS=14.81 Birr kg^{-1}, Price of barley=30 Birr kg^{-1} in gurawa market district

Conclusion

The result of soil laboratory shows that the soil of the experimental area was texturally sandy clay loam with the pH 6.02 which was slightly acidic. The CEC of was 37cmo (+) kg of soil which was high. The analysis revealed that the soil of the experimental site contains (0.914% OC, 1.58% OM and 0.14% N) which was low. Available P content of the soil was 8.2 mg kg^{-1} which was high range. Main effect of both NPS fertilizer rate and varieties had highly significant effect (p<0.001) on phenological, plant height, total tiller per plant and above ground biomass and the main effect of NPS fertilizers rates had significant influence on number of seed/spike. The maximum (54.43) number of seed per spike was recorded from EH1493. Grain yield was significantly and highly significantly (p<001) influenced by NPS fertilizers and varieties, respectively. The maximum grain yield (4592 kg ha^{-1}) was obtained from 200NPS kg $ha^{-1}$of fertilizer application. Thousand grain weights were highly significantly affected (p<001) by NPS fertilizer application. The highest thousand grain weights (49.90 gm) were attributed from the plots which received 200 NPS kg ha^{-1}. The main effect of NPS fertilizer rates and varieties had highly significant effect (p<0.001) on the straw yield of barley. The highest straw yield (7745 kg ha^{-1}) was obtained from application 200NPS kg ha^{-1} of blended fertilizer.

The nutrient uptake was significantly different (p<0.001) among the varieties. The maximum nutrient uptake (14.70 kg ha^{-1}) was observed from Cross#41/98 variety. However, the main effect of blended NPS fertilizers significantly influenced (p<0.05) agronomic use efficiency. The highest net benefit of 134798 Birr ha^{-1} with marginal rate of return (MRR) of 1042.47% was obtained in response to application of 200 kg blended NPS ha^{-1}. Thus, applications of 200 kg blended NPS ha^{-1} combined with 100 kg urea ha^{-1} rate is economically beneficial for production of barley yield as compared to the other treatments in the study area. But this result was at one location and at one season; so other study has to be repeated on more location and season to achieve best conclusion and recommendation for Gurawa district.

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