Peertechz

International Journal of Agricultural Science and Food Technology

LIFE SCIENCES GROUP

ISSN: 2455-815X DOI: https://dx.doi.org/10.17352/ijasft

Research Article

Response of Food Barley (*Hordeum vulgare* L) to NPS and Nitrogen (N) under limed conditions of acid soils at highland of Guji, Southern Ethiopia

Seyoum Alemu*, Yared Tesfaye and Aliyi Kedir

Bore Agricultural Research Center, Oromia Agricultural Research Institute, Bore, Ethiopia

Received: 22 August, 2023
Accepted: 28 August, 2023
Published: 29 August, 2023

***Corresponding authors:** Seyoum Alemu, Bore Agricultural Research Center, Oromia Agricultural Research Institute, Bore, Ethiopia, Tel: +251910316384; E-mail: seyoum23@gmail.com

ORCiD: https://orcid.org/0000-0001-9769-2071

Keywords: Liming; Yield; Fertilizer; Acidic *Soil*

Abstract

Barley is one of the major crops produced in Ethiopia in general and in specific in the study area. Even though it is such an important and major crop in the study area, its yield is very low due to many production constraints which include a lack of improved varieties, poor agronomic practice, Soil acidity problems, diseases, weeds, and low soil fertility in many parts of Ethiopia including Guji zone. The activity was conducted during the 2019-2021 main cropping season at Bore with the objective of determining the effect of NPS and N fertilizer rates on yield components and yield of Food Barley under limed conditions of acidic soil for highlands. The experiment was laid out in a split-plot design with three replications using the HB1307 Food Barley variety as a test crop. Four levels of NPS (0, 50, 100, and 150 kg ha^{-1}) and four levels of N (0, 23, 46, and 69 kg ha^{-1}) was used for these treatments which make a total of 16 treatment under limed and unlimed conditions. Analysis of the results revealed that all parameters were significantly ($p < 0.05$) affected by the interaction of the factors (NPS, N, and liming) as well as the main effects except date to 50% heading and days to maturity which did not significantly ($p < 0.05$) affected. The highest grain yield (3862 kg/ha) was obtained from the combination of 100 kg/ha NPS and 23 kg/ha. Therefore, the use of 100 kg ha^{-1} NPS and 23 kg ha^{-1} N is recommended for food barley production in the study area and other areas with similar agroecologies.

Introduction

Soil acidity is among the major land degradation problems worldwide. It is estimated that over 11 million ha of land and 32% of arable land are exposed to soil acidity around the world [1] which is caused by high rainfall, topographic factors, morphological factors, and severe soil erosion [2], which lead to high rate of weathering of the soil, high rate of leaching nutrients from soils, very rapid destruction of soil physical structure and texture, quick and severe erosion of the topsoil and acute drought stress are signals of severe soil acidity [1,3].

In Ethiopia, huge surface areas of highlands located in almost all regional states of the country are affected by soil acidity, which covers 40.9% of the Ethiopian total land affected by soil acidity [4]. Of these about 27.7% of these soils are dominated by moderate to weak acid soils (pH in KCl) 4.5 -5.5, and around 13.2% by strong acid soils (pH in KCl) <4.5) including the highland of Guji zone which has pH of 5.1.

In such acidic soil deficiencies of N. P, K, Ca, Mg, and micronutrients are common. Because of these circumstances a number of problems are observed which include loss of crop diversity, the decline in the yield of existing crops/reduced yield, lack of response to fertilizers, complete failure of cropping, poor plant vigor, uneven pasture, and stunted crop growth, poor nodulation of legumes, stunted root growth, persistence of acid-tolerant weeds, increased incidence of diseases, poor plant growth, nutrient deficiencies and imbalance, and abnormal leaf colors are major symptoms which indicate soil acidity problem [5].

A study on the important plant growth-limiting nutrients (Nitrogen and Phosphorus) revealed that acid soils dominate

Citation: Alemu S, Tesfaye Y, Kedir A (2023) Response of Food Barley (*Hordeum vulgare* L) to NPS and Nitrogen (N) under limed conditions of acid soils at highland of Guji, Southern Ethiopia. Int J Agric Sc Food Technol 9(3): 087-092. DOI: https://dx.doi.org/10.17352/2455-815X.000197

most of the southern and southwestern parts of the country and generally have low P content. Soils in the south (in which Guji is located) and southwestern parts including Sidamo, Ilubabor, and Keffa have high N_2 content and low P content (NFIA, 1993). This is due to the fixation of P in acidic soil. Thus, enhancing soil organic N and P mineralization in acid soils and speeding up the uptake efficiency of applied blended NPS fertilizers through liming is very important. In addition, sulfur fertilization helps in enhancing the uptake of N, P, K, and Zn in the plant [6]. Thus production of the crop is increased as the efficiency of the elements is enhanced due to the synergic effect. Even though this is the problem in our area, no research was done on liming and other acid soil management practices. The soil map of the study area is blended NPS (19% N, 38% P_2O_5 and 7% S) and it is important to supplement with nitrogen since nitrogen in NPS is small. Therefore it is important to determine the optimum rate of NPS and N with liming for the production of barley in acidic soil.

Objective

1. To assess the optimum and economical rate of NPS and N for Food Barley under limed and un-limed conditions.

2. To give proper fertilizer recommendations after liming.

Materials and methods

The activity was conducted at Bore districts for two years (2019-2021) during the main cropping season. The experiment was laid out in a split-plot design (limed and unlimed as the main plot and a combination of NPS and N (4x4) in a sub-plot on the plot size of 2.4m x 2.5m. The spacing was 20cm, 1m, and 1.5m paths between the row, plots, and blocks respectively. Food Barley, HB-1307 variety was used as seed source with 150kg/ha seeding rate. Management of non-treatment routines was similar for all experimental units including the control. The lime requirement of the soil was calculated based on its exchangeable acidity (Al^{3+} plus H^{1+}). The lime was evenly spread and incorporated up to 20cm depth by using a hand hoe one month before planting at an equal rate (3 t ha^{-1}) for all treatments for limed conditions.

Data collection and measurement

Crop phenology and growth parameters

Days to 50% Heading (DTH): It was determined as the number of days taken from the date of sowing to the date of 50% heading of the plants from each.

Days to 90% Physiological Maturity (DTM): determined as the number of days from sowing to the date when 90% of the peduncle turned to yellow straw color.

Plant height (cm): It was measured from the soil surface to the tip of the spike (awns excluded) of 10 plants from the net plot area at the maturity stage.

Spike length (cm): It was measured from the bottom of the spike to the tip of the spike excluding the awns from randomly tagged spikes from the net plot.

Yield components and yield

Number of tillers per plant: The number of tillers per plant was determined from 10 tagged plants per net plot at physiological maturity by counting the number of tillers after removing soils surrounding the tillers.

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

Grain yield (kg ha^{-1}): Grain yield was taken by harvesting and threshing the seed yield from the net plot area. The yield was adjusted to 12.5% moisture content as:

$$\text{Adjusted grain yield} = \frac{(100 - \text{MC}) \times \text{Unadjusted grain yield}}{100 - 12.5}$$

Where MC- is the moisture content of Food barley seeds at the time of measurement and 12.5 is the standard moisture content of Food barley in percent. Finally, yield per plot was converted to per hectare basis and the yield was reported in kg ha^{-1}.

Soil sampling and analysis

Soil samples were taken before planting randomly from the experimental site at a depth of 0-30 cm across the experimental field from 15 spots using an auger before planting and compositing. Then, the collected samples were air-dried at room temperature under shade and submitted to the laboratory, where ground to pass through a 2 mm sieve whereas for Organic Carbon (OC) and Nitrogen (N) determination, the soil was ground to pass through a 1 mm sieve

Working samples (1 kg) were obtained from prepared sample/composite and analyzed for selected physico-chemical properties mainly for soil texture, soil pH, Cation Exchangeable Capacity (CEC), and organic carbon, total N, available P and S using standard laboratory procedures.

Statistical data analysis

All data collected were analyzed using GenStat (18th edition) software [7]. Mean separation was done by using Fisher's protected Least Significant Difference (LSD) test at a 5% level of significance.

Economic analysis

The economic analysis was carried out by using the methodology described in CIMMYT [8] in which prevailing market prices for inputs at planting and outputs at harvesting were used. All costs and benefits were calculated on a hectare (ha) basis in Birr. The concepts used in the partial budget analysis were the mean grain yield of each treatment, the gross benefit (GB) ha-1 (the mean yield for each treatment), and the field price of fertilizers (the costs of NPS, Urea/N, and the application costs). The marginal rate of return, which refers to net income obtained by incurring a unit cost of fertilizer and its

Citation: Alemu S, Tesfaye Y, Kedir A (2023) Response of Food Barley (*Hordeum vulgare* L) to NPS and Nitrogen (N) under limed conditions of acid soils at highland of Guji, Southern Ethiopia. Int J Agric Sc Food Technol 9(3): 087-092. DOI: https://dx.doi.org/10.17352/2455-815X.000197

application, was calculated by dividing the net increase in yield of bread wheat due to the application of each fertilizer rate.

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 [8] 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 undominated treatments, respectively. For each pair of ranked treatments, the % Marginal Rate of Return (MRR) was calculated using the formula

$$MRR\ (\%) = \frac{\text{Change in NB}(NBb - NBa)}{\text{Change in TCV}(TCVb - TCVa)} \times 100$$

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 undominated treatments was 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, an 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 N (Birr 49.80 kg^{-1}) during sowing time. The cost of NPS, N, and application cost (Birr 600 ha^{-1}) and the average open price of bread wheat at Bore market was Birr 33 kg^{-1} in January 2021 during harvesting time.

Results and discussions

Soil experimental site physical and chemical properties

In Table 1 below, the result of selected physical and chemical properties of the experimental site was listed. The result indicated that the soil textural class is clay with a particle size distribution of 43% clay, 30% silt, and 27% sand. Thus, the soil of the experimental site is suitable for food barley. The pH of the soil was 4.48, which is strongly acidic according to the rating of Tekalign [9]. Thus, the soil needs acid management such as liming. The soil organic carbon content (3.1%) of the experimental site was moderate [9]. The analysis further indicated that the soil has medium total nitrogen (0.33%) according to the rating of Tekalign [9]. The results also show that the soil has low available phosphorus content (6.8 mg/kg) according to the rating of Cottenie [10]. According to EtioSIS [11] available sulfur of experimental soil is low (15.01 mg/kg).

The CEC of experimental soil is high (31.03 [Cmol (+) kg^{-1} soil] according to the rating of Landon [12] which indicates that the soil has a high capacity to hold exchangeable cations.

Crop phenology and growth parameters

Days to heading: ANOVA indicated that the interaction of NPS x N x Liming and main effects did not significantly ($p < 0.05$) affect days to 50% heading of Food barley (Table 2). The lack of significance might be the use of one variety for all treatments. In line with the findings of Haji, et al. [13] reported no significant heading on different blended fertilizer rates.

Days to 90% physiological maturity: ANOVA indicated that the interaction of NPS x N x Liming and main effects did not significantly ($p < 0.05$) affect days to 50% heading of Food barley (Table 1). Lack of significance might be the use of a similar variety for all treatments i.e. maturity of the crop is mainly controlled by the genetic makeup of a genotype (Table 2).

Plant height: ANOVA indicated that the interaction of the three factors (NPS, N, and liming) significantly ($p < 0.05$) affected plant height of Food barley as well as the main effects (Table 3). This might be due to the vital role of N fertilizer in vegetative growth and resulted in a significant influence on plant height as acidity is decreased. This result is consistent with Wubshet, et al. [14] who reported a significant difference in plant height barley through the integrated application of blended NPSB, Lime, and compost.

Spike length: The ANOVA indicated that significant ($p < 0.05$) effect of the factors (NPS, N, and liming) and the main effect on this parameter. The longest spikes (8.75 cm) were obtained at 100kg/ha NPS and 69 kg N ha^{-1} under limed conditions whereas the shortest spikes (6.44cm) were produced

Table 1: Selected physicochemical properties of the soil of the experimental site before planting.

Parameter	Result	Rating	Reference
Soil texture			
Clay (%)	43		
Sand (%)	27		
Silt (%)	30		
Textural Class	Clay		
pH (1: 2.5 H_2O)	4.84	Strongly acidic	Tekalign [9]
Total N (%)	0.33	Medium	Tekalign [9]
Organic Carbon (%)	3.10	Moderate	Tekalign [9]
Cation Exchange Capacity [Cmol(+)kg^{-1} soil]	31.03	High	London [12]
Available Phosphorus (mg/kg)	6.8	Low	Cottenie [10]
Available Sulfur (mg/kg)	15.01	Low	EthioSIS [11]

Table 2: Interaction effect of NPS, N & lime on Days to maturity.

	NPS Rate (kg/ha)	N rate (kg/ha)			
		0	23	46	69
Limed	0	136.1	134.5	136.5	135.1
	50	137.2	134.6	135.9	134.6
	100	135.8	135.1	135.8	135.5
	150	135.1	135.7	135.1	136.4
Un limed	0	137.1	135.1	135.8	134.1
	50	134.7	135.7	135.7	136.1
	100	134.5	135.5	136.5	135.8
	150	136.1	135.4	136.7	134.1
	Mean	135.56			
	LSD (5%)	NS			
	CV (%)	1.5			

Citation: Alemu S, Tesfaye Y, Kedir A (2023) Response of Food Barley (*Hordeum vulgare* L) to NPS and Nitrogen (N) under limed conditions of acid soils at highland of Guji, Southern Ethiopia. Int J Agric Sc Food Technol 9(3): 087-092. DOI: https://dx.doi.org/10.17352/2455-815X.000197

at control/0 NPS and 0 N kg ha⁻¹ under unlimed (Table 4). The increase in spike length at the highest NPS and N rates might have resulted from improved root growth and increased uptake of nutrients and better growth favored due to the interaction/ synergetic effect of the three nutrients at the highest rate. In line with this finding [15], reported the highest spike length (7.7cm) for Food barley at the rate of 50/150 kg N/P_2O_5 ha^{-1}.

Yield component and yield

Number of tillers per plant: The main effect (NPS) was significant ($p < 0.05$) on the tiller number produced per plant (Table 5) whereas the main effect of N rate and the interaction of the factors did not.

The highest number of tillers per plant (4.39) was obtained from the application of the highest NPS rate (150kg ha^{-1}) whereas the minimum number of tillers per plant (3.4) was produced at the control treatment. This might be due to the role of P found in NPS that helps in emerging radical and seminal roots during seedling establishment in barley [16]. In line with this result, Yare, et al. [17] reported a significant effect of NPS on the number of tillers per plant and the number of fertile tillers. However, the result did not agree with that of Wubshet, et al. [14] who reported the interaction effect of blended NPSB, lime, and compost on the number of tillers of Food barley.

Thousand Kernels Weight: The effect of NPS rates and liming and the main effects significantly ($p < 0.05$) influenced a thousand kernels weight of barley. The highest thousand kernels weight (42.67 g) was recorded at the combination of 150kg ha^{-1} NPS rate with liming. On the other hand, the minimum thousand kernel weight (36.16 g) was observed at control/ 0 kg NPS ha^{-1} under unlimed conditions. The thousand kernel weight obtained from the overall limed plots was significantly higher than the thousand seed weight from the unlimed plot/control. This might be due to the synergic effect of the nutrients which improve seed quality and size (Table 6).

Grain yield: The interaction effect of the three factors (NPS N rate, and liming) and their main effects significantly ($p < 0.05$) affected the grain yield of Food barley. Increasing NPS and N rates across limed conditions significantly increased grain yield. Thus, the maximum grain yield (3862 kg ha^{-1}) was recorded at a combined application of 100 kg ha^{-1} NPS and 23 kg ha^{-1} N. However the minimum grain yield (2045 kg ha^{-1}) was obtained at control treatment (0 kg NPS ha^{-1} and 0 kg ha^{-1}) (Table 7). The maximum grain yield at optimum rates of NPS and N under limed condition might be due to increased uptake of nutrients since liming improves the efficiency of

Table 3: Effect of NPS, N, and liming on plant height of Food barley.

	NPS Rate (kg/ha)	N rate (kg/ha)			
		0	23	46	69
Limed	0	100 hi	104.9 a-h	108.6 a-e	108.5 a-e
	50	106.5 a-h	101.6 d-i	107.2 a-h	107.2 a-h
	100	103.6 b-i	105.9 a-h	109.8 ab	112 a
	150	103.6 b-h	103.4 b-i	109.2 abc	109.9 ab
Un limed	0	96.2 i	108.4 a-e	105.5 a-h	108.2 a-f
	50	100.8 f-i	103.4 b-i	106.3 a-h	107.6 a-g
	100	101.3 e-i	106.3 a-h	102.4 c-i	109.1 abc
	150	108.8 a-d	100.6 ghi	105.7 a-h	108.1 a-f
	Mean	105.64			
	LSD (5%)	7.397			
	CV (%)	8.4			

This means that the same letter in the columns and rows are not significantly different at a 5% level of significance, CV (%): Coefficient of variation, LSD= Least Significant Difference at a 5% level.

Table 4: Interaction effect of NPS, N and liming on spike length of Food barley.

	NPS Rate (kg/ha)	N rate (kg/ha)			
		0	23	46	69
Limed	0	7.088 fgh	8.183 a-d	8.203 a-d	8.023 a-f
	50	8.351 a-d	8.245 a-d	7.695 b-g	7.206 e-h
	100	7.671 b-g	8.357 a-d	8.391 abc	8.755 a
	150	7.94 a-f	7.563 b-g	8.007 a-f	8.443 ab
Un limed	0	6.442 h	7.683 b-g	8.049 a-f	8.307 a-d
	50	7.613 b-g	7.41 d-g	7.987 a-f	8.03 a-f
	100	7.993 a-f	7.983 a-f	6.766 gh	8.094 a-e
	150	7.431 c-g	7.758 b-f	8.258 a-d	8.051 a-f
	Mean	7.87			
	LSD (5%)	0.967			
	CV (%)	10.8			

This means that the same letter in the columns and rows are not significantly different at a 5% level of significance, CV (%): Coefficient of Variation; LSD: Least Significant Difference at a 5% level.

Table 5: Effect of NPS rate on number of tillers for Food barley at Bore.

NPS Rate (kg/ha)	Number of Tillers per plant
0	3.44 b
50	3.941 ab
100	3.722 b
150	4.399 a
N Rate (kg/ha)	
0	3.59
23	4.008
46	3.912
69	3.991
Mean	3.88
LSD (5%)	NS
CV (%)	10.9

This means that the same letter in the columns and rows are not significantly different at a 5% level of significance, CV (%): Coefficient of Variation; LSD: Least Significant Difference at a 5% level.

Table 6: Effect of NPS, N and liming on TKW of Food barley.

NPS Rate (kg/ha)	Limed	Un limed
0	37.37 bc	36.16 c
50	40.47 ab	37.22 bc
100	42.04 a	40.78 ab
150	42.67 a	39.47 abc
Mean	39.52	
LSD (5%)	3.98	
CV (%)	15.8	

This means that the same letter in the columns and rows are not significantly different at a 5% level of significance, CV (%): Coefficient of Variation; LSD: Least Significant Difference at a 5% level.

Citation: Alemu S, Tesfaye Y, Kedir A (2023) Response of Food Barley (*Hordeum vulgare* L) to NPS and Nitrogen (N) under limed conditions of acid soils at highland of Guji, Southern Ethiopia. Int J Agric Sc Food Technol 9(3): 087-092. DOI: https://dx.doi.org/10.17352/2455-815X.000197

nutrients in acidic soil which directly and indirectly increase yield component and yield.

Similar to this result, Shiferaw and Antenah [18] reported the highest barley grain yield from the combined application of NPK and liming. Similarly, Hailu and Getachew [19] reported triple yield increases of barley by applying 3 t ha^{-1}. Wubshet, et al. [14] also reported the highest grain yield of barley (5386 kg ha^{-1}) by combined application of 611kg lime + 5 t compost + 150 kg NPSB + 100 kg KCl +72 kg N ha^{-1}.

Table 7: Interaction effect of NPS, N, and Liming on Grain yield of food barley at Bore.

		N rate (kg/ha)			
	NPS Rate (kg/ha)	0	23	46	69
Limed	0	2871 de	3226 a-e	3253 a-e	3274 a-e
	50	3264 a-e	3520 abcd	3193 a-e	3384 a-e
	100	2802 e	3862 a	3795 ab	3568 abc
	150	2961 cde	3502 a-d	3333 a-e	3125 b-e
Un limed	0	2045 f	3058 cde	3255 a-e	3321 a-e
	50	2979 cde	3158 b-e	3209 a-e	3552 a-d
	100	3145 b-e	3476 a-e	2983 cde	3196 a-e
	150	3078 cde	3496 a-d	3200 a-e	3103 cde
	Mean	3224.62			
	LSD (5%)	689.58			
	CV (%)	13.00			

This means that the same letter in the columns and rows are not significantly different at a 5% level of significance, CV (%): Coefficient of Variation; LSD: Least Significant Difference at a 5% level.

Partial budget analysis

Results of the total costs that vary, net benefits, and marginal rate of returns analysis are presented in Table 8. The experiment determines the economic benefits of the treatments that are used to develop recommendations from the agronomic data which enhances selection of the right treatment combination by farmers. The analysis results in this study indicated that the combined use of NPS and N fertilizers and liming resulted in higher net benefits than the control treatments without liming (Table 8).

As listed in Table 8, the highest net benefit (Birr 104576.14 ha^{-1}) was recorded at the combined application of 100 kg NPS + 23 kg N ha^{-1} under the limed condition as the lowest was from control treatment without liming. Since the marginal rate of return (MRR %) is used as the basis of fertilizer recommendation, the minimum acceptable rate of return should be between 50 to 100% [8]. In this experiment use of 100 kg NPS ha^{-1} and 23 kg N ha^{-1} under liming gave the maximum economic benefit of 104576.14 Birr ha^{-1} with a marginal rate of return (4953.519%). Therefore, on economic

Table 8: Partial budget analysis of the effect of NPS, N, and liming on food barley.

Treatments			Adjusted grain yield downwards by 10% (kg ha^{-1})	Gross Benefit (Birr ha^{-1})	Total variable cost (Birr ha^{-1})	Net return (Birr ha^{-1})	MRR (%)
	NPS (kg ha^{-1})	N (kg ha^{-1})					
Limed	Control	Control	2409.68	60242.05	0	60242.05	0
	0	23	2482.91	62072.73	3625	58447.73	50.50157
	0	46	2507.32	62682.95	4550	58132.95	65.97052
	0	69	2525.86	63146.59	4585	58561.59	1324.675
	50	23	2712.14	67803.41	5000	62803.41	1122.125
	50	46	2833.5	70837.5	5325	65512.5	933.5664
	50	0	2897.45	72436.36	5475	66961.36	1065.909
	100	23	4433.05	110826.1	6250	104576.1	4953.519
	100	46	4372.36	109309.1	6325	102984.1	D
	100	0	2797.64	69940.91	6375	63565.91	D
	50	69	3006	75150	6400	68750	20836.36
	150	0	3325.36	83134.09	7175	75959.09	1030.205
	150	23	3813	95325	7250	88075	16254.55
	100	69	3833.59	95839.77	7300	88539.77	1029.545
	150	46	3660.27	91506.82	8100	83406.82	D
	150	69	3453.41	86335.23	8175	78160.23	D
Unlimed	Control	Control	1508.73	37718.18	0	37718.18	0
	0	23	2155.09	53877.27	2875	51002.27	462.0553
	0	46	1916.86	47921.59	3800	44121.59	D
	0	69	1975.77	49394.32	3835	45559.32	4107.792
	50	23	2711.18	67779.55	4250	63529.55	4330.175
	50	46	2757	68925	4575	64350	252.4476
	50	0	2550.14	63753.41	4725	59028.41	D
	100	23	3192.68	79817.05	5500	74317.05	1972.727
	100	46	2748.95	68723.86	5575	63148.86	D
	100	0	2648.18	66204.55	5625	60579.55	D
	50	69	3066.14	76653.41	5650	71003.41	41695.45
	150	0	2692.64	67315.91	6425	60890.91	D
	150	23	3069.41	76735.23	6500	70235.23	12459.09
	100	69	3275.32	81882.95	6550	75332.95	10195.45
	150	46	2802.55	70063.64	7350	62713.64	D
	150	69	2734.77	68369.32	7425	60944.32	D

Where MRR (%) = Marginal Rate of Return; D= Dominated Treatment; Control = unfertilized & unlimed.

Citation: Alemu S, Tesfaye Y, Kedir A (2023) Response of Food Barley (*Hordeum vulgare* L) to NPS and Nitrogen (N) under limed conditions of acid soils at highland of Guji, Southern Ethiopia. Int J Agric Sc Food Technol 9(3): 087-092. DOI: https://dx.doi.org/10.17352/2455-815X.000197

grounds, together use of 100 kg NPS ha^{-1} and 23 kg N ha^{-1} under limed conditions gave a high yield and economical. In line with this result, Wubishet, et al. [14] reported that NPSB, Liming, and compost application is effective in attaining higher grain yield and economic benefit of food barley. Thus combined use of these rates under limed conditions is recommended for the production of food barley in the study area and other areas with similar agro-ecological conditions.

Summary and conclusion

Even though food barley is an important crop in the study area, its yield is below national due to different factors like soil acidity. Thus the activity was done during the 2019-2021 cropping season at Bore with the objective to determine the effect of NPS, N, and Liming on yield components and yield of food barley. The experiment was laid out in a split-plot design (limed and unlimed as the main plot and a combination of NPS and N (4x4) in a sub-plot on the plot size of 2.4m x 2.5m.

As analysis of the results indicated, all parameters were significantly ($p < 0.05$) affected by the interaction and main effect of the factors except date to 50% heading and date to maturity. This indicates how the factors are important in the production and productivity of food barley. Thus, using NPS, N, and lime increased yield and yield components of food barley. The highest grain yield (3862 kg/ha) was obtained from a combination use of 100 kg ha^{-1} NPS rate and 23 kg N ha^{-1} under liming. Therefore, the use of 100 kg NPS ha^{-1} and 23 kg N ha^{-1} under limed conditions is recommended for the production of food barley in the study area and other areas with similar agroecologies. In addition to this, liming and other acidic soil management should also be done in the future since the soil acidity of Guji Highland ranges from acidic to strongly acidic.

Acknowledgment

Our special thanks go to the Bore Agricultural Research Center (BoARC) for providing us with the required facilities and budget for conducting our research. We also thank all cereal team members for assisting in the fieldwork and data collection.

References

1. Eswaran HP, Reich P, Beinroth F. Global distribution of soils with acidity. In: AC. Moniz, AMC. Furlani, RE. Schaffert, NK. Fageria, CA. Rosolem and H Cantarella, eds. Plant-Soil Interactions at Low pH. Campinas, Brazil: Brazilian Soc. Soil Sci. 1997; 159-164.
2. Abebe M. Nature and Management of Acid Soils in Ethiopia. 2007. http://www.eiar.gov.et/Soil/soils acid.pdf.
3. Pearce RC, Sumner ME. Apparent salt sorption reactions in unfertilized acid sub-soil. Soil Science Society of American Journal. 1997; 61: 765772.
4. Schlede H. Distribution of acid soils and liming materials in Ethiopia. Ethiopian Institute of Geological Surveys, Ministry of Mines and Energy, Addis Ababa, Ethiopia. 1989.
5. Kang BT, Juo ASR. Effect of forest clearing on soil chemical properties and crop performance. Land clearing and development in the tropics. 1986; 383394.
6. Thomas F. Rice nutrient disorder and nutrient management. Oxford Printing Ltd. 1st ed. 2000.
7. GenStat. GenStat Procedure Library Release. 18th edition. VSN International Ltd. 2012.
8. CIMMYT (Centro Internacional de Mejoramiento de Maiz y Trigo/_International Maize and Wheat Improvement Center). From Agronomic Data to Farmer Recommendations: An Economic Work Book. Mexico, D.F.: CIMMYT. 1988.
9. Tadessa T. Soil, plant, water, fertilizer, animal manure, and compost analysis. Working Document No. 13. International Livestock Research Center for Africa, Addis Ababa. 1991.
10. Cottenie A. Soil and plant testing as a basis of fertilizer recommendations. FAO soil bulletin 38/2. Food and Agriculture Organization of the United Nations, Rome. 1980.
11. EthioSIS (Ethiopia Soil Information System). Soil fertility status and fertilizer recommendation atlas for Tigray regional state, Ethiopia. 2014.
12. Landon JR. Booker Tropical Soil Manual: A handbook for soil survey and Agricultural Land Evaluation in the Tropics and Subtropics. Longman Scientific and Technical, Essex, New York. 1991; 474.
13. Jewaro Beketa H, Kefale D, Yoseph T. 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. 2017; 8(4): 2319-1473.
14. Demissie W, Kidanu S, Abera T, Raghavaiah CV. Effects of Lime, Blended Fertilizer (NPSB) and Compost on Yield and Yield Attributes of Barley (Hordium Vulgare L.) on Acid Soils of Wolmera District, West Showa and Ethiopia. Ethiop J Appl Sci Technol 2017; 8 (2): 84-100.
15. Menamo M, Masebo N. The Effect of Application of Different Rate N-P Fertilizers Rate on Yield and Yield Attributes of Bread Wheat in Case of Chancha Woreda, Southern Ethiopia. Journal of Natural Sciences Research. 2016; 6(5): 63–66.
16. Cook RJ, Veseth RJ. Wheat health management. The American Phytopathological Society, USA. 1991; 152.
17. Tesfaye Y, Alemu S, Asefa K, Teshome G, Chimdesa O. Effect of Blended NPS Fertilizer Levels and Row Spacing on Yield Components and Yield of Food Barley (Hordeum Vulgare L.) at High Land of Guji Zone, Southern Ethiopia. Academic Research Journal of Agricultural Science and Research. 2020; 8 (6): 609-618.
18. Boke S. Fekadu A. Lime and NPK effect on soil acidity and yield of barley in different acid soils of the southern region, Ethiopia. International Journal of Natural Sciences Research. 2014; 2(7): 113-122.
19. Hailu T, Getachew B. Eragrostis tef (Zuccagni) Trotter. In Plant Resources of Tropical Africa 1. Cereals and pulses. (Eds M. Brink and G. Belay). Prota Foundation, Wageningen/ Backhuys Publishers, Leiden/ CTA, Wageningen, Netherlands. 2006; 68-72.

Citation: Alemu S, Tesfaye Y, Kedir A (2023) Response of Food Barley (*Hordeum vulgare* L) to NPS and Nitrogen (N) under limed conditions of acid soils at highland of Guji, Southern Ethiopia. Int J Agric Sc Food Technol 9(3): 087-092. DOI: https://dx.doi.org/10.17352/2455-815X.000197