Asian Journal of Applied Science and Technology (AJAST)
Volume 8, Issue 4, Pages 100-105, Oct-Dec 2024

Evaluation of Blended NPSB Fertilizer on Yield and Yield Components of Barley (*Hordeum vulgare* L.) under Rain-fed Condition at Cheguarkudo in Tsegedie District Western Tigray, Ethiopia

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DOI: https://doi.org/10.38177/ajast.2024.8410

Article Received: 15 September 2024 *Article Accepted: 22 November 2024* *Article Published: 28 November 2024*

ABSTRACT

Field experiment was conducted with the objective of evaluating the effects of blended (NPSB) fertilizer rates on yield and yield components of Barley at Cheguarkudo in Tsegedie Wereda of Tigray Ethiopia during the main rainy seasons of 2019 and 2020. The experiment was carried out on farmers' field with three replications using randomized complete block design (RCBD), comprised of 8 treatments 0, 50, 100, 150, 200, 250, 300 kg/ha NPSB and recommended NP 64kg/ha N and 46 kg P_2O_5/ha. Composite soil samples were also initially collected from 0-20 cm depth of the fields and analyzed. The blended fertilizer rates were applied at the time of sowing while N was applied in split into two applications. Phosphorus di ammonium phosphate (DAP) was also applied at planting time. Plant height, spike length, straw yield, grain yield data were collected. Soil analyses of the experimental fields revealed sandy loam soil textural classes, strongly acid soil reaction (pH), low organic matter (OM), low total N and low Olsen P. Application of different rates of NPSB fertilizers significantly ($P \leq 0.05$) and positively influenced most of the crop parameters. Highest result was obtained at 300 kg/ha blended. Partial budget analysis showed highest and profitable yield at 150 kg NPSB/ha was recorded for Barley. This profitable rate could be recommended for the experimental area.

Keywords: Blend; NPSB; Fertilizer; Barley; Yield; Tigray; pH; OM; Cheguarkudo; Tsegedie.

1. Introduction

Barley (*Hordeum vulgare* L.) is one of the most stable food and economically important widely used cereal crop in Ethiopia next to teff, maize, wheat and sorghum [6]. But production of barley in Ethiopia fall under low fertility soils [14]. Mainly on the use and application of nitrogen and phosphorus fertilizers in the form of urea and di ammonium phosphate in blanket recommendation for the major food crop barley fertilizer use trend in Ethiopia has been focused.

Poor soil fertility and extreme exhaustion of plant nutrients from the soil are the major factors limiting crop production in different agro-ecological zones of Tigray. Nutrient mining due to sub optimal fertilizer use coupled with agronomical unblended fertilizer uses have favored the emergence of multi nutrient deficiency in Ethiopian soils [1], [2] which in part explain fertilizer factor productivity decline and stagnant crop productivity conditions encountered despite continued use of blanket recommendations.

However, information on the application of blended fertilizer rate (NPSB) for the food barley was not determined in the study area. Thus, the review was done to assess the effect of blended NPSB fertilizer. Overall objective of this study was to evaluate the barley crop response to the application of different rates of blended NPSB fertilizer on yield and yield components of food barley production Tsegedie Wereda western Tigray Ethiopia.

1.1. Study Objectives

This study aims to determine and summarize the following specific objectives regarding the NPSB Blended fertilizer in Tsegedie Wereda of Tigray, Ethiopia. The specific objectives were: (i) to evaluate the barley crop response to the application of different rates of blended NPSB fertilizer, (ii) to evaluate the blended fertilizer NPSB

for food barley production, (iii) To determine the effect of blended fertilizers compared to blanket recommendation NP, and (iv) to recommend profitable rate of NPSB for barley production for the experimental area.

2. Materials and Method

2.1. Description of Experimental Sites

The field experiment was conducted under rain fed conditions in Endaslasie high land Tsegedie Wereda, district Western Tigray Ethiopia. The area is located at $13^0$14' 21" to 13^0 44' 46" N and 36^0 27' 44" to 37^0 45' 05" E longitudes with altitude of 1053 to 2889 m above sea level. The mean annual temperature of the area is 13.2 ^oC and the mean annual rain fall varies from 700-1800 mm. The dominant soil types in the Tsegedie highlands are mainly humic cambisols [10].

2.2. Experimental procedures

The field was prepared well before sowing by plough twice by oxen and leveled for seed bed. Due to the acidity problem of the area recommended (22.17t kg ha^{-1}) lime was applied to neutralize the soil before sowing. Seeds of barley were planted in rows 3*3m long with spacing of 0.2m between rows. The experiment consists of eight levels of NPSB. The levels of NPSB were 0, 50, 100, 150, 200, 250, 300 and blanket recommendation of N and P fertilizers (46 kg ha^{-1} N and 46 kg $ha^{-1}P_2O_5$). The blended fertilizer rates were applied at the time of sowing while N was applied in split into two applications. Phosphorus di ammonium phosphate (DAP) was also applied at planting time. Top soil (0-20cm) was collected from the experimental site, air dried and sieved through a 2 mm diameter mesh and laboratory analysis were made for texture, PH, organic matter, total N, available P, exchangeable Acid and CEC following their respective standard procedures at Mekelle soil research center. All agronomic operations were done. The experiment was arranged in completely randomized design (RCBD) replicated three times.

2.3. Data collection

Data collection were plant height, spike length, number of tillers, number of kernel, grain yield and biomass yield were obtained by harvesting an area of 3*3m from the middle of each plot.

2.4. Statistical analysis

GenStat® 18th Edition (VSN International, Hemel Hempstead, UK) was used to perform analyses of variance (ANOVA). Differences between means of significant variables were Duncan's Multiple Range Test (DMRT) at the 5% significance level. For profitability of Teff production using different fertilizer level, marginal rate of return (MRR) was calculated as the change in net revenue (NR) divided by the change in total variable cost (TVC) of the successive net revenue and total variable cost levels [4].

3. Results and Discussion

3.1. Selected Physicochemical Properties of Soils of the Experimental Sites

The analytical results of the experimental soil indicated that the soil textural class at Cheguarkudo was Sandy loam (Table 1).

Table 1. Initial Surface (0-20 cm) physical and chemical property of the experimental field

					Exchangeable ($cmol^{+}\ kg^{-}$)	
Texture	**P^H**	**OM (%)**	**TN (%)**	**Av.P ($mg\ kg^{-1}$)**	**Acid**	**CEC**
Sandy loam	4.91	2.54	0.12	3.72	3.23	23.83

Note: OM= Organic Matter; TN= Total Nitrogen Av.P =Available phosphors; CEC= Cation Exchange Capacity.

The analytical result indicated that (Table 1) the soil pH was 4.91. The pH was strongly acidic according to the rating made by [12] which suggests the significant of quantity of exchangeable H^+ and $Al3^+$ ions which associated with acidity. Soil pH values ranges from found that the optimum for wheat and barley production [11]. The OM and TN were 2.54 and 0.12% respectively and rated low as per [12]. Available P content of the experimental site is 3.72mg $^{kg-1}$ low as per the rating by [5]. According to [9] the Cation exchange capacity of (CEC) of the soil was 23.83$cmol^{+}\ kg$ is low to moderate.

3.2. Growth and yield parameters of barley

Analysis of variance (ANOVA) presented on Table 2 revealed that the application NPSB fertilizer had significant influence ($P \leq 0.01$) on plant height of barley with increasing rates blended NPSB fertilizer application rates. The maximum plant height (64.67cm), the minimum height (54.07cm), was obtained from the application of 300 NPSB kg ha^{-1} blended fertilizers and from the control respectively. Spike length barley did not show significantly effect in the treatments. Several authors, [7], [8] and [3] reported that macro and micro (Nitrogen, Phosphorus Sulfur and boron) fertilizers application can increase yield and yield components of wheat in combination.

3.3. Grain and Straw yield

Grain yield was significantly affected by NPSB fertilizer rate ($P \leq 0.01$) effect on the grain yield (Table 2). The highest mean grain yield was obtained (2037 kg ha^{-1}) with the application of 300 kg ha^{-1} NPSB. The mean grain yield advantage obtained was varied in all the treatments compared with the control. The lowest yield (1285 kg ha^{-1}) was obtained from the control plot. The highest yield had 63.08% yield increment over control and 89.54% over the blanket recommendation. This result agrees with the previous finding [13] who reported that the application of 150 kg ha^{-1} NPSB blended with compost increases grain yield of barley.

The effect of fertilizer rates have demonstrated significant ($P<0.05$) effect the teff straw yield (Table 2). The lowest straw yield (1981 kg ha^{-1}) was recorded in the control treatment the mean highest straw yield (3702 kg ha^{-1}) was recorded from plots applied with 300 kg NPSB ha^{-1} which is statistically at par with recorded of the other treatments. The highest straw yield had 53.51% straw yield increment over control and 94.05% over the blanket recommendation. This result in harmony with the finding of [13] who reported that the application of 150 kg ha^{-1} NPSB blended with compost increased 5.9 t ha^{-1}straw yields.

Table 2. Effect of NPSB on yield and yield components of barley

Treatments (NPSB, kg ha^{-1})	**Plant height (cm)**	**Spike length (cm)**	**Grain yield (kg ha^{-1})**	**Straw yield (kg ha^{-1})**
0	54.07c	6.13	1285c	1981e

Rec. N and P (64 -46)	63.03ab	6.71	1824ab	3182bcd
50	61.18b	7.33	1772b	2947d
100	60.81b	6.83	1814ab	3053cd
150	62.81ab	6.61	1851ab	3218bcd
200	64.04a	8.04	1937ab	3367abc
250	61.22b	6.77	1801b	3431ab
300	64.67a	7.03	2037a	3702a
P	<0.001	0.052	<0.001	<0.001
CV	2.67	7.4	8.26	9.14

3.4. Partial budget analysis

Highest grain and straw yield was recorded at the highest blend fertilizer rate under 300 kg NPSB ha^{-1}.Though, the recorded increases at this rate it was statistically at par with NPSB fertilizer rate of other treatments except the control. Considering only the advantage of grain yield improvement, 300 kg ha^{-1} NPSB fertilizer would be recommended and was also statistically similar with the other treatments. However, according to the marginal rate of return the rate of 150 kg NPSB ha^{-1} was found economically profitable compared to other treatments.

Table 3. Partial budget analysis of NPSB blended fertilizer rates for grain and straw yield of barley

Treatments (NPSB-NP kg ha^{-1})	Adjusted GY	Adjusted SY	TVC	Grain revenue	Straw revenue	Total revenue	Net revenue	MRR (ratio)	MRR (%)
Control (0)	1157	1783	0	15034.5	5705.2	20739.7	20739.7	0	0
50	1642	2864	1260.2	21340.8	9164.1	30504.9	28704.5	1.262	126.2
100	1595	2652	1733.3	20732.4	8487.3	29219.7	27054.6	2.711	2.711
Rec.NP (46-46)	1633	2748	1859.3	21223.8	8792.6	30016.4	27486.6	D	D
150	1666	2896	2206.5	21656.7	9267.8	30924.5	28086.7	1.386	138.6
200	1743	3030	2679.6	22662.9	9696.9	32359.8	29466.0	1.370	137.0
250	1621	3088	3152.8	21071.7	9881.2	30952.9	27694.4	D	D
300	1833	3332	3626	23832.9	10661.7	34494.6	30871.4	1.150	115.0

* GY = Grain yield; SY = straw yield; TVC = Total variable cost, MRR = Marginal rate of return.

4. Conclusion

The study revealed that blend NPSB fertilizer improved grain and straw yields of barley. The highest grain and straw yield was recorded at the highest blend fertilizer rate under 300 kg ha^{-1} NPSB blended fertilizer. According to the marginal rate of return the rate of 150 kg NPSB ha^{-1} was found economically profitable compared to other treatments. Therefore, further study should be done on effects of NPSB in grain quality and single nutrient based experiment should also be carried out to evaluate each nutrient contribution for barley production. Furthermore Blended fertilizer NPSB at a rate of 150 kg ha^{-1} for barley production on experimental site should be used as a bench mark in addition to this impacts of the Blended fertilizer NPSB seem more significantly valued in increasing the barley production. Thus, further study across different years, locations and soils is very important.

Declarations

Source of Funding

This study has been supported by Tigray Agricultural Research Institute, Ethiopia.

Competing Interests Statement

The authors declare no competing financial, professional, or personal interests.

Consent for publication

The authors declare that they consented to the publication of this study.

Acknowledgements

The authors would like to thank Humera Agricultural Research Center, Tigray Agricultural Research Institute, Ethiopia for their assistance and financial support to undertake the research.

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