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ORIGINAL ARTICLE

Evaluation of different blended fertilizer types and rate for better Production of barley at Gurage Zone, Gumer woreda

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Information of blended fertilizer (NPS and NPSB) rate and type for specific site and crop was not determined for barley production in the study area. The study was undertaken with the objective of evaluating the effects of different blended fertilizers rate and type on barley yield and yield components. The Experiment was conducted on four farmer's field during the period of 2019 cropping season at Gummer Woreda, Southern Ethiopia. The experiment consists of seven treatments; (1) control, (2) NPS (142 kg NPS+159 kg urea ha^{-1}), (3) NPSB (150 kg NPSB+41 kg urea ha^{-1}), (4) NPSB (200 kg NPSB+72 kg urea ha^{-1}), (5) NPSB (250 kg NPSB+102 kg urea ha^{-1}), (6) NPSB (100 kg NPSB+161 kg urea ha^{-1}) and (7) recommended NP (92 Kg N+69 P_2O_5). The treatments were arranged in randomized complete block design replicated three times in each farm. Agronomic parameters measured were analysed using Proc GLM procedures in the SAS 9.4 program. Economic analysis was also performed to investigate the economic feasibility of the fertilizers for barley production. The treatments applied revealed significant effect on growth parameters, yield and yield components of barley over Control. However, there was no significant difference obtained between fertilized plots. The highest grain yield (4786 Kg ha^{-1}) was obtained from application of 92 Kg N+69 kg P_2O_5 which has no significant difference with treatment application of 142 kg NPS+159 kg urea ha^{-1}. The economic analysis also revealed that application of 92 Kg/ha N, 69 kg P_2O_5 showed the highest net benefit and MRR compared to others. Therefore we recommended 92 Kg/ha N, 69 kg P_2O_5 since it produced high grain yield, high MRR, high net benefit and relatively small total cost of production, for Barley production at Gumer areas.

Keywords: Barley production, Blended fertilizers, Fertilizer rate, Fertilizer type, Net benefit.

Introduction

Barley (*Hordeum vulgare L.*) is one of the most staple food and economically important widely used cereal crop in Ethiopia next to teff, maize, wheat, and sorghum (CSA, 2019). However, production of barley in Ethiopia fall under low fertility soils (Yihenew, 2002). Similarly, Woldeyesus et al. (2002) investigated that low barley productivity was obtained in the highland of Ethiopia due to low soil fertility. Low soil fertility is one of the constraints to sustainable agricultural production and productivity in Ethiopia (Wakene et al., 2007).

In Ethiopia, fertilizer use trend has been focused mainly on the use and application of nitrogen and phosphorous fertilizers in the form of Di-ammonium phosphate (DAP) (18-46-0) and Urea (46-0-0) or blanket recommendation for the major food crops. According to Bekabil et al. (2011), the lack of appropriate fertilizer blends and lack of micronutrients in fertilizer blends are the national problem which is major constraints to crop productivity. Balanced fertilization is the key to sustainable crop production and maintenance of soil health. It has both economic and environmental consideration. Unbalanced application of plant nutrients with least study might have aggravated the depletion of nutrient elements in soils including the recently identified K, S and micronutrients (Zn, B).

EthioSIS (Ethiopian Soil Information System) indicated that, the soils of Gumer area also deficient in sulfur and boron in addition to phosphorous and nitrogen, which all potentially hold back crop productivity despite continued use of N and P fertilizer as per the blanket recommendation. The application of micronutrient (B) in combination with macronutrients NPS fertilizers is improving nutrient concentration and uptake (Redai et al., 2018). On the other hand, imbalanced fertilizer use results in low fertilizer use efficiency leading to less economic returns and a greater threat to the environment (Abiye et al., 2004). However, information on the blended fertilizer (NPS and NPSB) rate and type, especially for barley, was not determined for the study area. Therefore, this study was conducted with the objective of identifying the best fertilizer rate and type for barley production at Gumer District, Southern Ethiopia.

Materials and Methods

Description of the study area

The study was conducted during 2019 main cropping season under rain fed field condition in Gumer Woreda of the Gurage Zone, Abeke Kebele to identify the best fertilizer rate and type for barley production. The research site was situated between 9°5'59''N latitude and 43°53'48'' E longitude at an altitude of 2689 m above sea level.

Treatments and experimental layout

The experiment was conducted on four farms in 2019 cropping season. Identified blended fertilizer type for Gumer area was obtained from EthioSIS map which were released by ATA. Accordingly, NPSB (F2) was used in different rates and NP was added as positive control. Treatments including the control treatment were assigned randomly to the experimental plots within a block. Seven treatments were laid out in randomized complete block design with three replications. The treatments were: no fertilizer (Control), NPS (F1)=92, 54, 10 (142 kgha^{-1} NPS+159 kg ha^{-1} urea top dressing, NPSB (F2)=46,54,10, 1.07 (150 kg ha^{-1} NPSB+41 kg ha^{-1} urea-top dress), NPSB (F2)=69,72,13, 1.4 (200 kg NPSB+72 kg ha^{-1} urea-top dress), NPSB (F2)=92,90,17, 1.7 (250 kg ha^{-1} NPSB+102 kg ha^{-1} urea-top dress), NPSB (F2)=92, 36, 10,0.71 (100 kg ha^{-1} NPSB+161 kg ha^{-1} urea top dress) and NP=92N and 69 P_2O_5 (200 kg Urea and 150 kg DAP ha^{-1}). Blended fertilizers were applied at planting and Urea applied in two split rates, i.e. at the time of sowing and after 35 days. Barley variety (HB 1307) was used as test crop. The plot size was 3 m × 3 m (9 m^2) with 1 m space between plots. The seed was drilled in 20 cm row spacing at 100 kg ha^{-1} seed rate. The other crop management practices were applied uniformly for all plots as recommendation for the crop.

Data collection and measurement

Soil sampling and analysis: Before conducting the experiment, thirteen representative sub samples were taken to make one composite soil sample. The samples were collected from experimental site at plow depth of 0-20 cm and analyzed at Areka Agricultural Research Center soil laboratory by using standard laboratory procedures. The soil sample was air-dried and ground to pass through a 2 mm sieve. Soil pH (pH-H_2O) was determined (1:2.5 soil to solution ratio) using a glass electrode attached to a digital pH meter (Page, 1982), soil texture was determined by hydrometer method (Day, 1965). Methods as described by Walkley and Black for organic carbon, and wet oxidation Kjeldahl method was used to determine Total N, as described by Jackson (1967). Available P was determined using the Olsen extraction method (Olsen and Dean, 1965).

Agronomic parameters: Growth data were collected from the net plot area 2 m × 2 m (4 m) of randomly selected five plants. Measurements of yield attributes were taken at physiological maturity of the crop prior to harvest. Number of tillers was recorded and calculated per meter square. Plant height was collected at flowering, by measuring from the base of the plants to the apex. Spike length was measured at flowering. Above ground biomass was harvested and weighed then calculated in hectare basis. Finally for grain yield, the dried yield which was harvested from the plot was weighed and calculated per hectare basis. Grain moisture content was determined and grain yield was adjusted to 12% moisture content. Straw yield was recorded after uniform air drying of barley for two weeks. Harvest index was calculated as the percentage ratio of grain yield to the total above ground biomass yield.

Economic analysis: The market cost of barley was 14 Ethiopian Birr (ETB) kg. The fertilizer cost was calculated for the cost of each fertilizers of DAP (15.10 Birr kg^{-1}), Urea (13.95 Birr kg^{-1}), NPS (15.05 Birr kg^{-1}), NPSB (14.08 Birr kg^{-1}) and transport cost was 50 Birr per 100 kg. Cost of land preparation, field management, harvest, threshing, protection, storage, post-harvest, and others were assumed to remain the same among the treatments. Analysis of marginal rate of return (MRR%) was carried out for non-dominated treatments, and the MRRs were compared to a minimum acceptable rate of return (MRR) of 100% in order to select the optimum treatment (CIMMYT, 1988).The net benefit per hectare for each treatment is the difference between the gross benefit and the total Variable costs. The average yield was adjusted downward by 10% to reflect the difference between the experimental field and the expected yield at farmers' fields and with farmer's practices from the same treatments (CIMMYT, 1988).

Statistical analysis: Analyses of variance (ANOVA) were carried out using Statistical Analysis Software (SAS) version 9.4. Whenever treatment effects were significant, mean separations made using the least significant difference (LSD) test at the 1% level of probability.

Results and Discussion

Physicochemical properties of the experimental field soil

The initial surface soil test characteristics indicated that soil was clay loam in texture based on soil textural classification triangle with moderately acidic pH, 5.85 (Table 1). Organic carbon content (4.49) was within the range of medium according to Landon (1991), who classified the organic carbon content of soil <4%, 4-10%, and >10% as low, medium and high respectively, and the total nitrogen content was high according to the same author. The available P and K were very low According to Jones (2003).

Table 1. Characteristics of experimental soils before planting at depth of 0–20 cm.

Soil properties								
pH	**OC%**	**TN%**	**P**	**K**	**Texture**	**Clay**	**Sand**	**Silt**
5.85	4.49	0.31	20.19	83.93	clay loam	36	30	34

Effect of blended fertilizer on yield and yield components

Data presented in Table 2 showed that application of different blended fertilizers had significant influence (P<0.01) on plant height which measured at physiological maturity. The highest mean height of 117.19 cm was recorded in barley plots received 142 kg NPS+159 kg ha^{-1}. This result was at par with the result obtained from application of 92 Kg N, 69 kg P_2O_5 kg ha^{-1}. In contrast, control plots showed significantly lower plant height compared to all other treatments. In addition, application of blended fertilizer at different rate resulted in statistically similar result. Addition of NPS fertilizer increased plant height by 48.3 cm compared to control (69.5 cm). Spike length of barley responded significantly to applied fertilizer. The highest spike length (6.95 cm) and highest number of tiller (3.35) was obtained with application of 92 Kg N, 69 kg P_2O_5 kg ha^{-1}. This showed an advantage of 23% and 53% increase in spike length and number of tiller, respectively as compared to control plots (Table 2). The possible reason for increased number of kernels per spike could be that applied fertilizer as nutrient sources. This result is consistent with Mitiku et al. (2014) who observed that application of 5 t ha^{-1} farmyard manure along with 75% of recommended NP gave highest number of productive tillers and highest number of grains per spike at Adiyo and Ghimbo, respectively.

Data presented in Table 2 showed that application of different blended fertilizers had significant influence (P<0.01) on biomass and grain yield of barley. In general, the highest spike length (6.95 cm), above ground biomass (10860.7 kg) and grain yield (4786 kg) were obtained from application of 92 kg N, 69 kg P_2O_5 kg ha^{-1}. In addition, highest plant height (117.19 cm) was obtained from application of NPS=142 kg NPS+159 kg ha^{-1} which was at par with the result obtained from application of 92 Kg N, 69 kg P_2O_5 kg

ha^{-1}. The lowest result was obtained for all parameters from the control treatment. The results are in accordance with those of Melkamu et al. (2019) who reported applications of different blended fertilizer rates significantly improved the barley growth, yield and yield components. However in our case, application of different blended fertilizer did not increase additional yield of barley from plot received NP fertilizer, even had statistically lower yield. This result is supported by Melkamu et al. (2019) who reported that the higher yield result which obtained from blended fertilizer had no significant difference from NP fertilizer. Therefore a micro nutrient deficiency which was identified by EthioSIS is not faceable. In addition, the plots that received NPSB fertilizer type at different rate were statistically not different for all growth and yield parameters.

Table 2. Mean yield and yield components of barley as affected by different rates of blended fertilizers at Gumer area.

Treatments	Spike Length (cm)	Tiller No	Plant Height(cm)	Biomass (kg ha^{-1})	Grain yield (kg ha^{-1})	HI
Control	5.4^{d}	1.65^{b}	69.5^{c}	3731.6^{d}	1932^{d}	34.1
NP=92,69	6.95^{a}	3.35^{a}	106.4^{ab}	10860.7^{a}	4786^{a}	30.6
NPS=92, 54, 10	6.26^{bc}	2.66^{b}	117.19^{a}	9018.1^{b}	4256^{ab}	32
NPSB=46,54,10, 1.07	5.96^{c}	2.33^{b}	93.9^{b}	7184.7^{c}	3503^{c}	33
NPSB=69,72,13, 1.4	6.35^{bc}	2.54^{b}	98.17^{b}	8953.3^{b}	3981^{bc}	31
NPSB=92,90,17, 1.7	6.45^{b}	2.43^{b}	96.78^{b}	9212.5^{b}	3965^{bc}	30
NPSB=92, 36, 10,1.07	6.36^{bc}	2.38^{b}	91.67^{b}	8027.3^{cb}	3891^{bc}	32.6
LSD (0.01)	0.46	0.46	18.87	1245.4	5.99	Ns
CV(%)	9.09	22.88	23.96	18.68	19.46	6.58

Mean values followed by the same letters in each column and treatment showed no significant difference not significantly different at $p \leq 5\%$ level of significance; LSD=Least Significant Difference; CV=Coefficient Variation.

Economic analysis

The dominance analysis (Table 3) indicated that except treatment 2 and 7, other treatments were dominated by the treatments with lower variable cost with higher net benefit. The highest net return of 55033.23 birr with highest MRR value of (6840.6%) was obtained from application of 92 Kg N, 69 kg P_2O_5 which revealed the treatment as economically superior and profitable than the rest of the treatments (Table 3). This recommendation is also supported by CIMMYT (1988) which stated that farmers should be willing to change from one treatment to another if the marginal rate of return of that change is greater than the minimum acceptable rate of return.

Table 3. Partial budget and dominance analysis of blended fertilizers for barley at Gumer woreda.

Treatments	Av. Yield	Adj. Yield	GB (EB/ha)	TCV (EB/ha)	NB (EB/ha)	MRR(%)
Control	1932	1738.8	24343.2	0	24343.2	----
NPSB=46,54,10, 1.07	3530	3177	44478	2842.85	41635.15	608.3D
NPSB=92, 36, 10,1.07	3891	3501.9	49026.6	3829.095	45197.51	361.2
NPSB=69,72,13, 1.4	3981	3582.9	50160.6	3999.545	46161.06	565.3D
NPS=92, 54, 10	4256	3830.4	53625.6	4546.52	49079.08	533.5D
NPSB=92,90,17, 1.7	3965	3568.5	49959	5121.325	44837.68	737.9D
NP=92,69	4786	4307.4	60303.6	5270.37	55033.23	6840.6

Av. G=average yield, Adj. G=adjusted yield kg ha^{-1}, TVC=Total Variable Cost, MRR%: Marginal Rate of Return, D=Dominated.

Conclusion

The experiment was done to evaluate the effects of different blended fertilizers rate and type on barley yield and yield components at Abeke Kebele, Gumer district, Southern Ethiopia. The result of the study showed that application of different blended and recommended fertilizer significantly affected growth, yield and yield components of barley over Control. However, there was no significant difference obtained between fertilized plots. The highest grain yield (4786 Kg ha^{-1}) was obtained from application of 92 Kg N+69 kg P_2O_5. In terms of economic feasibility also, application of 92 Kg N, 69 kg P_2O_5 kg ha^{-1} accrued the highest net return of 55033.23 Eth-birr ha with MRR of 6840.6% and advisable for farmers to maximize barley grain yield kg ha^{-1} and economic return. Therefore, based on the yield response and economic indicators, it is recommended to apply 92 Kg N, 69 kg P_2O_5 kg ha^{-1} Abeke kebele, Southern Ethiopia and areas with the same soil conditions and agro ecology.

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