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Evaluation of Organic Liquid Fertilizer "ECO-GREEN" on the Yield and Yield Component of Malt Barley

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Abstract: The organic fertilizers help to sophisticate the soil structure by nourishing it, enhancing its productivity and at the same time protecting it from being eroded away. Nitrogen and phosphorus fertilizers are the major limiting factors in most soils. The highland vertisols of Ethiopia are prone to nutrient deficiency especially of N and P as the result of monocropping and leaching losses. An experiment was conducted at Sinana District of Bale highlands, South-eastern Ethiopia on farmers field to evaluate the effect of Organic Liquid Fertilizer "ECO-GREEN" on the Yield and Yield Component of Malt Barley (Singitan Variety). The experiment was laid out in randomized complete block design using three replications on six levels of treatment. There was significant variation observed in Grain Yield, plant height, seed spike length, seed per spikelet, number of Tiller and Biomass Yield between the level of treatments. Grain yield and yield components were higher at ECO-GREEN level 4 (80 lit/ha^{-1}) across all experimental sites (Shalo, Robe Area and Sambitu). The lower grain yield and yield components observed on the control (sole water) and followed by ECO-GREEN level 1 (20 lit/ha^{-1}) and 2 (40 lit/ha^{-1}). Grain yield was positively correlated with all yield components. Grain yield is very strongly associated with the number of seed per spike. Grain yield is positively correlated and highly associated with seed spike length and Biomass Yield and associated with Plant Height and Number of Tiller.

Keywords: ECO-GREEN, Grain Yield, Malt Barley, Organic Liquid Fertilizers

1. Introduction

Organic fertilizers are those fertilizers which are manufactured using organic substances which are bio-degradable, i.e., Organic fertilizers are naturally occurring fertilizers and nutrient enhancers of the soil [1]. The organic fertilizers help to sophisticate the soil structure by nourishing it, enhancing its productivity and at the same time protecting it from being eroded away. Artificial and inorganic fertilizers have certain disadvantages as they have to be applied again and again [2]. They become a necessity to the soil or else the productivity is hampered. They act as a drug for the soils as till the time the soils are fertilized, they remain productive or else they die down. Eutrophication, nutrient pollution is caused due to extra application of the artificial fertilizers [3].

Organic fertilizers retain a blanket like cover on the soil thus enabling it to recapture the moisture level and not let it out. Thus, it also helps to recover the stress levels of the soil by maintaining its moisture content. The organic fertilizers help to sophisticate the soil structure by nourishing it, enhancing its productivity and at the same time protecting it from being eroded away. Artificial and inorganic fertilizers have certain disadvantages as they have to be applied again and again [4]. They become a necessity to the soil or else the productivity is hampered. They act as a drug for the soils as till the time the soils are fertilized, they remain productive or else they die down. Eutrophication, nutrient pollution is caused due to extra application of the artificial fertilizers [6].

Organic Liquid Fertilizer provides soil with organic matter essential for microorganisms. It is one of the building blocks for fertile soil rich in humus. It releases the nutrients in slow and consistent at a natural rate that plants are able to use. No danger of over concentration of any element, since microbes must break down the material. Since it encourages soil life, Microbes convert the organic matter to the form of nutrients that plants need. Earthworms feeding on organic materials aerate and loosen the soil [7].

It had proven that long-term chemical fertilization without applying organic materials impaired soil health and plateaued rice yield, although there were so many improved rice varieties [8]. Decomposed organic materials, in combination with plant growth-promoting bacteria, are environmentally friendly and reduce synthetic fertilizer use in plant production [9]. Poor soil fertility is one of the major factors that reduce yield of barley in Ethiopia [10]. An integrated use of organic and inorganic fertilizers for tackling soil fertility depletion and sustainably increasing crop yields had a paramount importance [11]. Different research findings have shown that neither inorganic fertilizers nor organic sources alone can result in sustainable productivity [12]. Integrated soil fertility management involving the judicious use of combinations of organic and inorganic resources is a feasible approach to overcome soil fertility constraints and contribute high crop productivity in agriculture [13]. To replenish soil fertility depletion applying organic liquid fertilizer is essential for barley [14].

Studies on the levels and timings of foliar nitrogen and organic liquid fertilizers on barley production is lacking in the highlands of Bale. Therefore, the current study is initiated with the following objectives: to determine the best ECOGREEN fertilizer rate on Malt Barley, and to determine the effect of ECOGREEN fertilizer on soil properties.

2. Materials and Methods

2.1. Description of the Study Area

The experiment was conducted at Robe Area, Shalo and Sambitu in Sinana district of Bale Zone, South eastern Oromia in 2018/2019 G.C. Robe Area located at latitude of N 7°06' and longitude of E 40°02' with altitude of 2456 m.a.s.l. Shalo located at latitude of N 7°04' longitude of E 40°11' with altitude of 2450 m.a.s.l. Sambitu located at latitude of N 7°10' and longitude of E 40°5' with altitude of 2407 m.a.s.l. The major soils of the area are cambisols and vertisols with clayey to sandy loam. The district is characterized by bimodal rainfall pattern receiving peak amounts in April and September. The minimum average temperature is 10.72°C, maximum mean temperature of 21.98°C and the average total annual rainfall of the experimental site was 925 mm.

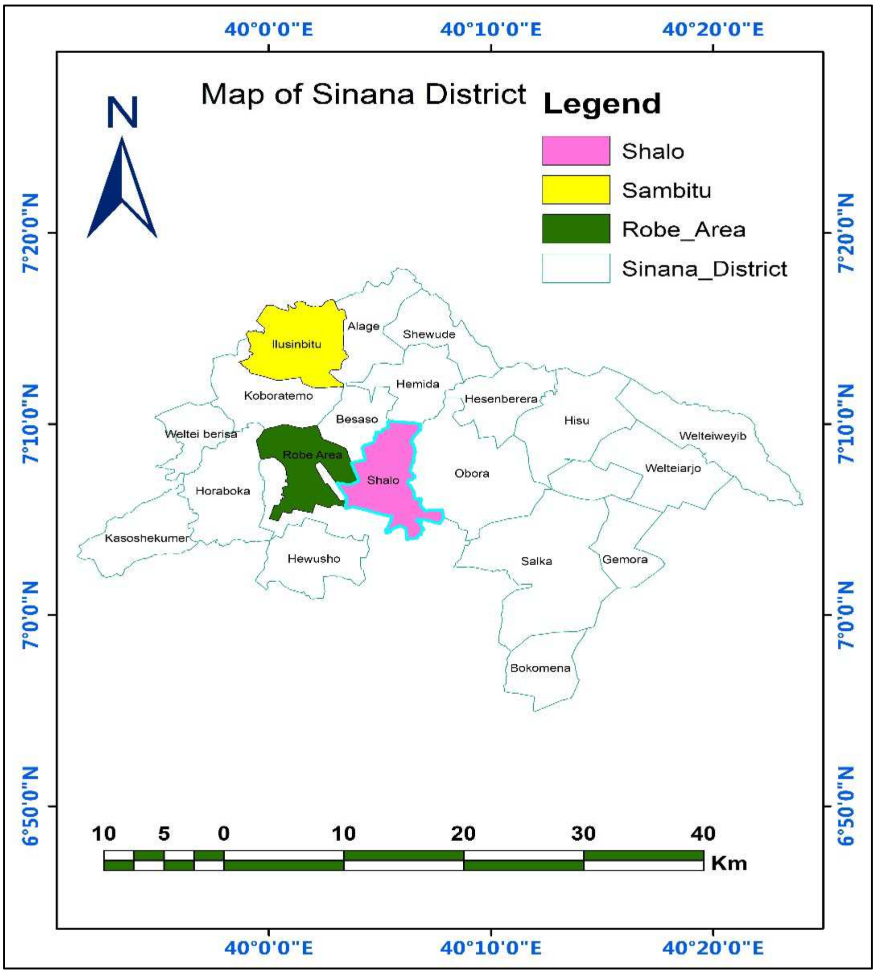

Figure 1. Map of the study area.

2.2. Experimental Design

The experiment was laid out in randomized complete block design using three replications for Singitan variety of Malt Barley. The seed was sawn in rows. Treatments was six levels of ECO-GREEN having one control (T1=Control (Sole water); T2=1% (20 lit/ha^{-1}); T3=2% (40 lit/ha^{-1}); T4=3% (60 lit/ha^{-1}), T5=4% (80 lit/ha^{-1}) and T6=5% (100 lit/ha^{-1}). The ratio of ECO-GREEN to water was 1:20 which mean one-liter ECO-GREEN added to 20-liter water. The treatments applied at 15, 30, 60, and 90 days after emergence (DAE). The plot size=3m × 3m (9m^2), having 15 rows, 3 m long and 20 cm apart. Organic liquid fertilizer "Eco-Green" was applied early in the morning or late afternoon so the ultra violet rays from the sun doesn't sterilize the beneficial biology in extract fertilizer.

Data Collection: Agronomic Parameters such as Yield and Yield components of Malt Barley such as Plant height (cm), Seed Spike Length (cm), Seed per Spike (No), Number of Tiller (No), Biomass Yield (kg) and Grain Yield (kg) was collected.

2.3. Data Management and Statistical Analysis

The all collected agronomic and soil data across locations was properly managed using the EXCEL computer software and subjected to the analysis of variance (ANOVA) using Linear Model of the R software Version 4.1.2. Linear models are typically fit in R through the lm() function [16]. The total variability for each trait quantified using LSD.test Model at 0.05 levels of significance [5].

3. Results and Discussion

3.1. Yield and Yield Components

Analysis of variance (ANOVA) showed that there was significant variation observed in Grain Yield, plant height, seed spike length, of seed per spikelet, number of Tiller and Biomass Yield between the level of treatments (Table 1). The highest mean Grain Yield (4220 kg/ha^{-1}) obtained on 80 lit/ha^{-1} Eco-green level and the lowest (1592) from the control. There was statistically significant variation of Grain Yield between the control and Eco-green levels (20, 40, 60, 80, and 100 lit/ha^{-1}). There was statistically significant variation of Plant Height between the control and Eco-green levels (60, 80, and 100 lit/ha^{-1}). The control and Eco-green levels (20 and 40 lit/ha^{-1}) statistically responsive similarly. There was no statistically significant variation of Plant Height between the Eco-green levels 60, 80, and 100 lit/ha^{-1}. There was statistically significant variation of Seed Spike length between the treatment levels. The longest seed spike length (7cm) obtained from Eco-green level of 80 lit/ha^{-1} and the lowest (3cm) from the control. There was no statistically significant variation of seed spike length between the Eco-green levels 40 and 60 lit/ha^{-1}. The highest average number of Seed per Spikelet (39) recorded on Eco-green level 80 lit/ha^{-1} and the lowest (16) on the control. There was no statistically significant variation of seed per spike between the Eco-green levels 40 and 60 lit/ha^{-1}. There was statistically significant variation of seed per spikelet between the control and Eco-green levels 20, 40, 60, and 100 lit/ha^{-1}. The higher average number of Tiller (4.3 and 4.6) obtained from the Eco-green level 80 and 100 lit/ha^{-1} respectively and the lower (0.6) from the control. There was no statistically significant variation Number of Tiller between the control and Eco-green levels 20, 40 and 60 lit/ha^{-1}. The highest average Biomass Yield (7055 kg/ha^{-1}) occurred on the Eco green level 80 lit/ha^{-1} and the lower (3276 and 3542 kg/ha^{-1}) from the control and 20 lit/ha^{-1} Eco-green level. There was no statistically significant variation of Biomass Yield between the control and Eco-green level 20 lit/ha^{-1}. There was no statistically significant variation of Biomass Yield between the Eco-green levels 40 and 60 lit/ha^{-1}. There was statistically significant variation of Biomass Yield between the Eco-green levels 60 and 80 and 100 lit/ha^{-1}. All yield and yield parameters are best suited on Eco-green level of 80 lit/ha^{-1}.

Table 1. *Response Yield and Yield Components to Organic Liquid Fertilizer ECO-GREEN.*

Eco-green Level (lit/ ha^{-1})	GY (kg/ha^{-1})	PH (cm)	SPL (cm)	SPS (No)	NT (No)	BMY (kg/ha^{-1})
0 (Control)	1592e	74b	3e	16e	0.6c	3276d
1 (20 lit/ha^{-1})	2252d	75b	4d	22d	1.1c	3542d
2 (40 lit/ha^{-1})	3261c	78b	5bc	26c	1.3bc	4445c
3 (60 lit/ha^{-1})	3334bc	82a	4.6c	27c	2.1c	4590bc
4 (80 lit/ha^{-1})	4220a	83a	7a	39a	4.3a	7055a
5 (100 lit/ha^{-1})	3561b	86a	5.4b	34b	4.6a	4837b
CV	8.55	5.02	14.63	5.02	37.7	7.39
Mean	3037	68.26	4.741	27.68	3.726	4624
LSD (0.05)	244.86	3.7	0.65	1.33	0.8	327.78

GY= Mean Grain Yield(kg/ha^{-1}), PH=Plant Height(cm), SPL=Spike Length(cm), SPS=Seed per Spikelet (Number), NT=Number of Tiller (Number), BMY=Biomass Yield (kg/ha^{-1}).

3.2. Correlation Analysis Among Parameters

Grain yield is positively correlated with all yield components (Table 2). Grain yield is very strongly associated with the number of seed per spike. Grain yield is positively correlated and highly associated with seed spike length and Biomass Yield and associated with Plant Height and Number of Tiller. To identify correlation between yield and yield components the below R script code used cor(MB_2011_ECOGREEN1[5:10]).

Table 2. *Pearson's correlation analysis between yield and yield components.*

Parameters	PH	SPL	SPS	NT	BMY	GY
PH	1.0000000	0.6722558	0.7210500	0.7424617	0.6151996	0.6969251
SPL	0.6722558	1.0000000	0.8700746	0.6952745	0.9149665	0.8507989
SPS	0.7210500	0.8700746	1.0000000	0.8530371	0.8816360	0.9506880
NT	0.7424617	0.6952745	0.8530371	1.0000000	0.7291971	0.7704280
BMY	0.6151996	0.9149665	0.8816360	0.7291971	1.0000000	0.8673483
GY	0.6969251	0.8507989	0.9506880	0.7704280	0.8673483	1.0000000

GY= Mean Grain Yield(kg/ha^{-1}), PH=Plant Height(cm), SPL=Spike Length(cm), SPS=Seed per Spikelet (Number), NT=Number of Tiller (Number), BMY=Biomass Yield (kg/ha^{-1}).

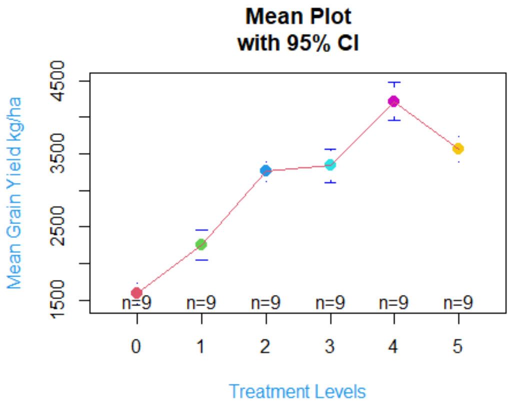

Figure 2. *Interaction Plot of Mean Grain Yield Across Location vs Treatment.*

plotmeans(GY~TRT, data = MB_2011_ECOGREEN1, xlab="Treatment Levels", ylab="Mean Grain Yield kg/ha", pch=c(20), col.lab=4, cex = 2, main="Mean Plot\nwith 95% CI", col=c(2:8)).

The mean of each response as affected by the treatments plotted using "plotmeans" function by linear model in R. Software version 4.1.2. It is observed that there was significant variation of mean grain yields between the treatment levels (Organic Liquid ECO-GREEN fertilizer) at all treatments level. The higher mean grain yields 4220 kg/ha recorded on treatment level 4 (80 lit/ha) of Organic Liquid fertilizer ECO-GREEN. Similarly, the highest grain yield reported from liquid organic fertilizer [15].

For visual presentation, the mean of each response as affected by the treatments plotted using "boxplot" function by linear model in R. Software version 4.1.2.

Boxplot (GY~TRT, data = MB_2011_ECOGREEN1, col=2:8, pars = list (boxwex = 0.8, staplewex = 0.5, outwex = 0.5, xlab = "TRT (TRT = Treatment Levels)", ylab = "Mean Grain Yield kg/ha", main = "BoxPlot", las=1, pch = 4, cex = 5, cex.axis=1, cex.lab=1, col.axis=1, col.main=1, col.lab=4, font.axis=2, font.lab=2, font.main=2, border = "dodgerblue")).

The box plot is comparatively short on treatment levels 2 and 5 this suggests that overall mean grain yield have a high level of agreement with each other. The box plot is comparatively tall, one box plot is much higher or lower than another (Obvious differences between box plots) on treatment levels 4 and the remaining others (0, 1, 2, 3, and 5) this could suggest that there was a high variation of yield response between treatment groups. In other word the treatments hold quite different yield response. This revealed that the highest mean grain yield response (kg/ha^{-1}) recorded on the treatment level 4 than the others. The box plot for treatment level 4 gave the highest response of mean grain yield than the equivalent plots for the others treatment levels (0, 1, 2, 3, and 5). The long upper whisker in the treatment level 3 and 5 means that treatments yield response is varied amongst the most positive quartile group, and very similar for the least positive quartile group.

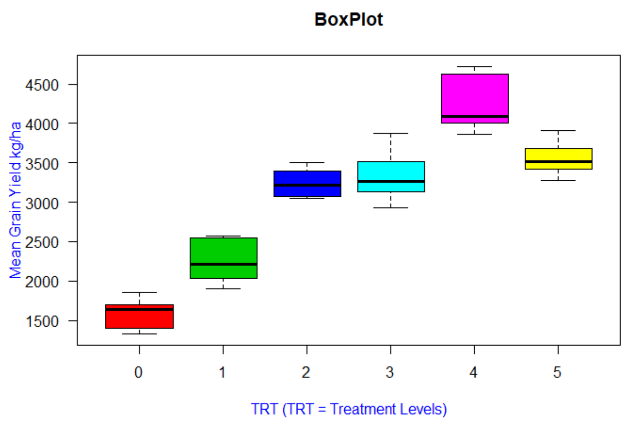

Figure 3. *Box Plot of Mean Grain Yield vurses Treatment.*

4. Conclusion and Recommendation

The soils of Ethiopian highlands are mainly deficient in organic matter, nitrogen and phosphorus because of nutrient mining by cereal monocropping and leaching losses where deficiency of these elements reduces yield and quality of crops. Malt Barley is produced in highland vertisols of Ethiopia mainly for industrial purposes. Grain yield is a response parameter considered by the Researchers and farming community to validate and recommend fertilizer trial. Appropriate fertilization practices based on actual limiting nutrients and crop requirement for a given crop is economic and judicious use of fertilizers for sustainable crop production. According to this study Organic Liquid Fertilizer "ECO-GREEN" on the yield and yield components of Malt Barley showed that it would be promising to grow Malt Barley in the study area compared to Control. Thus indicated that Malt Barley productivity in the study sites was increased due to foliar application of Organic Liquid Fertilizer "ECO-GREEN", in which the results of the study revealed that the maximum mean grain yield (4220 kg/ha^{-1}) and total biomass yield (7055 kg /ha^{-1}) were recorded for 80 lit/ha^{-1} Organic Liquid Fertilizer "ECO-GREEN" in row method of sowing. To improve the current unbalanced fertilizer application and soil mining of the study sites, preventative actions such as adopting sustainable soil fertility replenishment and Improvement strategy, soil conservation practices, and avoiding unbalanced fertilizers can help to rebuild the soil conditions to increase crop productivity. From this point of view, the 80 lit/ha^{-1} Organic Liquid Fertilizer "ECO-GREEN" application was the best treatment for producing high grain and Biomass yield. Therefore, this treatment can be suggested for the farmers in the study area. However, the experiment has to be conducted in multi-location for sound recommendation than the present study.

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