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On-Farm Evaluation of the Potentials of Orga-Fertilizer on the Yields of Sorghum in Habru District of Eastern Amhara Region in Ethiopia

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Abstract
A study was conducted on farmers' fields in Habru District of the Amhara Region in Ethiopia. The objective of the study was to evaluate the competence of Orga-fertilizer with inorganic NP fertilizers in improving sorghum yields. The treatments evaluated were 1. Control (zero fertilizer), 2. 100% of the recommended inorganic N/P fertilizers (46/46 kg N/P_2O_5 ha^{-1}), 3. 100% of the recommended Orga-fertilizer (200 kg ha^{-1}) + 100% of the recommended inorganic N-fertilizer (46 kg ha^{-1}) and 4. 100% recommended Orga-fertilizer (200 kg ha^{-1}) in a randomized complete block design with six replications**.** Laboratory analysis results showed that 100 kg Orga-fertilizer used in the study was comprised of 1 kg total N, 23 kg P_2O_5, 21 kg Ca and 21 kg organic matter. Statistical analysis of the agronomic data collected in two consecutive experimental years revealed that there was a significant grain yield difference ($P \leq 0.05$) among the treatments. Combined application of 100% the recommended Orga-fertilizer with 100% of the recommended inorganic N-fertilizer gave the highest grain yield of 2.4 t ha^{-1} as compared to 2.0, 1.9 and 1.7 t ha^{-1} grain yields obtained from sole application of 100% of the recommended inorganic N/P fertilizers, sole application of 100% of the recommended Orga-fertilizer and the control treatments, respectively. Hence, combined application of 100% of the recommended Orga-fertilizer with 100% of the recommended inorganic N-fertilizer, is recommended for better sorghum yield returns at Habru District and similar agro-ecologies.
Keywords: Orga-fertilizer, inorganic fertilizers, integrated use of Orga-fertilizer and inorganic NP fertilizers.

1. Introduction

Low soil fertility is among the major factors limiting crop production and productivity in North Eastern part of Ethiopia. This is common in many tropical cropping systems where fertilizer use is low and little or no agricultural residues are returned to the soil for maintaining soil fertility. The long aged cropping history coupled with leaching and intensive erosion has led deleterious depletion of the soil nutrients (Hailu 1988). Deforestation and overgrazing due to over population growth in the region has aggravated the problem. Consequently, soils can no longer sustain crop production with their existing fertility status.

Accordingly, there is an encouraging growing demand and utilization of fertilizers in the country (Getachew 1991). As a result, the use of chemical fertilizers in Ethiopia has made a contribution to crop yield growth to date, although there is potential for further improvement (Asnakew *et al.* 1991). Nevertheless, fertilizer is applied by less than 45% of farmers, on about 40% of the area under crop in the country, and most likely at below-optimal dosage levels (Dercon and Hill 2009). This is true from the fact that chemical fertilizers are costly and inaccessible for the most of resource poor farmers in the country. Besides to their unaffordability to most of the resource poor farmers, inorganic fertilizers have a counter long term effect to the soil and the environment (Hedge.et al. 1993).

Thus, integrated soil fertility management encompassing organic and inorganic fertilizers has a paramount importance to reverse the aforementioned situation both in the short and long run. According to Palm et al. (2001), organic fertilizers play a dominant role in soil fertility management through its short-term effects on nutrient supply and long-term contribution to soil organic matter formation. Thus, organic fertilizers like farm yard manure and compost are being used as an alternative fertilizer source.

However. though farmyard manure is available in the crop-livestock farming system of Eastern Amhara, these organic fertilizers are required in very large quantities to supply equivalent amount of plant nutrients as inorganic fertilizers do. In addition, these organic fertilizers are the major sources of fuel and are being consumed by most of the farmers. In spite of the abovementioned facts, framers are using part of these organic fertilizers to replenish plant nutrients in their farm lands. Hence, an alternative organic fertilizer for the farmers and lifelong increment of soil fertility in the prevailing situations is required. Orga-fertilizer produced from slaughter and factory waste products in the organic fertilizer producing factory combined with inorganic fertilizers is tested in this research for its capacity and competency in improving crop yield returns. The table below shows plant nutrient composition of Orga-fertilizer (Bulletin of NAFMAC):

Table 1. Percent composition of some plant nutrients in Orga-fertilizer

Characteristics (% by mass)	Results
Total N	1.00
Total phosphorus as P_2O_5	23.0
Potassium	0.32
Calcium	21.0
Magnesium	0.30
Zinc	0.01
Iron	0.16
Manganese	0.09
Sodium	0.23
Organic matter	20.98
P^H of 10% solution	6.64

As it is presented in the above table Orga-fertilizer mainly contains P_2O_5, OM and Ca; the phosphorus content is half to that of the inorganic fertilizer, DAP. It is highly environment friendly and very economical as compared to the inorganic fertilizers. It is practiced in many countries like Kenya and bestows a fruitful production. However, in eastern Amhara, little scientific effort has been made so far to evaluate and recommend such an alternative and highly potential organic fertilizer. It is to fill this gap, to evaluate its competence in improving grain yield as compared to the inorganic fertilizers and to asses the capability of Orga-fertilizer in maintaining soil fertility, that this research was conducted:

2. Materials and Experimental Procedures

2.1 Experimental site Description

The experiment was conducted on framers' fields in 2004 and 2005 at Sirinka, which is located in Habru District of Eastern Amhara Region in Ethiopia. The study site is located at 508 km away from the capital city Addis Ababa in the north east direction at an altitude of 1850 masl and Geographical coordinates of $11^0 45' 00''$ N and $39^0 36' 36''$. The average annual rainfall of the study area was 945 mm and the mean maximum and minimum temperatures were 26 and 13°C, respectively.

The soils of the study site are characterized as a clay to clay loam texture with black to brown color, conducive pH condition for most crop growth, low organic carbon, low total nitrogen and medium available phosphorus (Table 1). The dominant soil type in the study area, based on the FAO/UNESCO System (FAO-UNESCO 1994), is Eutric Vertisol.

Table 1. Physical and chemical properties of the surface soils (0-20 cm) at the study site

Property	Value/Result
pH (H_2O)	6.98
OC (%)	1.35
Total N (%)	0.07
Available P. (mg kg^{-1})	11.77
CEC ($cmol_C$ kg^{-1})	56.44
Texture	Clay to Clay loam
Exchangeable K ($cmol_C$ kg^{-1})	1.27
Exchangeable Ca ($cmol_C$ kg^{-1})	36.85
Exchangeable Mg ($cmol_C$ kg^{-1})	12.61

2.2 Sampling and Laboratory Analysis of Soil Samples

Composite soil samples were collected at a depth of 0-20 cm from each farm fields before planting. The collected soil samples were analyzed for organic matter and available P content according to the Walkely Black wet digestion (Walkley and Black 1934) and the Olsen's colorimetric methods (Olsen 1952), respectively.

2.3 Experimental Design and Procedures

The experiment was laid on RCB design with six replications. Six permanent experimental farmers' fields were used as replications. The treatments tested were control (zero fertilizer), 100% of the recommended inorganic N/P fertilizers (46/46 kg N/P_2O_5 ha^{-1}), 100% of the recommended inorganic N-fertilizer (46 kg ha^{-1}) along with 100% of the recommended Orga-fertilizer (200 kg ha^{-1}), and sole 100% of the recommended Orga-fertilizer (200 kg ha^{-1}).

3. Results and Discussions

3.1 Grain Yield

The statistical analysis of variance revealed a highly significant ($p \leq 0.01$) and a significant ($p \leq 0.05$) difference among treatments in the first and second experimental years, respectively. As it is summarized in Table 2, statistical analysis of the data collected in each year and combined over the two experimental years indicated that the highest significant ($p \leq 0.05$) grain yield, 2.4 t ha^{-1} was obtained from the combined application of 100% of the recommended Orga-fertilizer (200 kg ha^{-1}) with 100% of the recommended inorganic-N fertilizer (46 kg ha^{-1}) followed with significant ($p \leq 0.05$) difference by the sole application of 100% of the recommended inorganic fertilizers N/P (46/46 kg N/P_2O_5 ha^{-1}).

In both experimental years, sole application of 200 kg ha^{-1} Orga-fertilizer gave statistically similar grain yield with the application of 100% of the recommended N/P fertilizers. Combined application of 100% of the recommended N fertilizer with 100% of the recommended Orga-fertilizer had 25.4%, 14.3%, and 9.1% better yield advantages over the control, application of 100% of the recommended N/P fertilizers and application of 100% of the recommended Orga-fertilizer, respectively.

Table 2. Treatment means comparison of grain yield (kg ha^{-1}) of sorghum in each experimental year, and the combined analysis

Treatments*	2004	2005	Combined over two years
Control (zero fertilizer)	2252.6c	1331.2b	1791.9c
46/46 kg N/P_2O_5 ha^{-1}	2758.6ab	1422.9b	2090.8b
46 kg N ha^{-1} + Orga-fertilizer (200kg ha^{-1})	3086.3a	1719.4a	2402.9a
Orga fertilizer (200kg ha^{-1})	2543.3bc	1399.5b	1971.4bc
Grand mean	2660.2	1468.3	2064.2
CV %	12.5	12.9	15.0
LSD	409.1	232.4	256.1

*Means within a column followed by the same letter are not significantly (0.05) different.

Meat factory by product as Orga-fertilizer was also shown in barley and rape seed to be an effective phosphorus fertilizer compared to rock phosphate (Bekele & Höfner 1993). It was proved by Jeng et al. (2006) that meat factory organic waste was an effective nitrogen and phosphorus fertilizer in spring wheat and barley.

3.2 Biomass Yield

As it is shown in table 3 below, combined application of 200 kg Orga fertilizer ha^{-1} with 46 kg inorganic N ha^{-1} effected the highest significant (α=0.05) biomass yield. Individual application of 46/46 kg N/P_2O_5 ha^{-1} and 200 kg Orga fertilizer ha^{-1} could give significantly (α=0.05) higher biomass yield than the control treatment. Biomass yields of 14.2, 13.0, and 11.7 t ha^{-1} could be obtained from the test plots treated with 200 kg Orga fertilizer ha^{-1} along with 46 kg N ha^{-1}, sole 46/46 Kg N/P_2O_5 ha^{-1} and sole 200 kg Orga-fertilizer ha^{-1}, respectively. Application of 200 kg Orga fertilizer ha^{-1} along with 46 kg N ha^{-1}, sole 46/46 Kg N/P_2O_5 ha^{-1} and sole 200 kg Orga-fertilizer ha^{-1} had 30.6, 24.2, and 15.4% higher yield advantages, respectively, than the control treatment. The abovementioned statistical differences among treatments held true in both experimental years for the treatment by year interaction was not significant.

Table 3. Treatment means comparison of biomass yield (kg ha^{-1}) of sorghum in each experimental year, and the combined analysis

Treatments*	2004	2005	Combined over two years
Control (zero fertilizer)	12451.9c	7290.7c	9871.3d
46/46 kg N/P_2O_5 ha^{-1}	16522.2a	9528.7ab	13025.5b
46 kg N ha^{-1} + Orga-fertilizer (200kg ha^{-1})	17928.4a	10547.5a	14238a
Orga fertilizer (200kg ha^{-1})	14243.8b	9088.6b	11666.2c
Grand mean	15286.6	9113.9	12200.2
CV %	9.3	9.8	10.1
LSD	1743.5	1102.8	1016.9

*Means with the same letter are not significantly (0.05) different.

3.3 Stover Yield

Combined application of 200 kg Orga-fertilizer ha^{-1} with 46 kg N ha^{-1} could effect higher significant stover yield than application of 46/46 kg N/P_2O_5 ha^{-1}, and 200 kg Orga-fertilizer ha^{-1}. The combined statistical analysis over years, as shown in Table 4, indicated that application of 200 kg ha^{-1} Orga-fertilizer along with 46 kg N ha^{-1} could give the highest significant stover yield, 10.2 t ha^{-1}, when it is compared with the stover yields of 9.4 t ha^{-1}, 7.9 t

ha^{-1} and 6.6 t ha^{-1} obtained by applying 46/46 kg N/P_2O_5 ha^{-1}, 200 kg ha^{-1} Orga-fertilizer, and the control treatment, respectively.

Table 4. Treatment means comparison of stover yield (kg ha^{-1}) of sorghum in each experimental year, and the combined analysis

Treatments*	2004	2005	Combined over two years
Control (zero fertilizer)	8792.6b	5068.5b	6637.3c
46/46 kg N/P_2O_5 ha^{-1}	12131.5a	6768.5a	9450.0a
46 kg N ha^{-1} + Orga fertilizer (200 kg ha^{-1})	12500.0a	7185.2a	10200.8a
Orga fertilizer (200 kg ha^{-1})	10225.4b	6046.3ab	7978.7b
Grand mean	10912.4	6267.1	8566.7
CV %	10.8	14.5	13.6
LSD	873.7	1121.4	963.0

*Means with the same letter are not significantly (0.05) different.

4. Conclusion and Recommendations

Soil fertility decline is one of the principal factors contributing to low productivity of crops and food insecurity in Sub-Saharan Africa. Crops are the major agricultural products in Ethiopia which most of the people in the country rely on for their daily food and dietary requirements. Among the cereal crops, sorghum is the most important crop in the lowlands of Northeast Ethiopia. Thus, a study was conducted to evaluate the combined use of factory produced Orga-fertilizer with inorganic N and P fertilizers on the yields of sorghum. The study results revealed that application of 100% of the recommended Orga-fertilizer (200 kg ha^{-1}) along with 100% the recommended inorganic N fertilizer (46 kg ha^{-1}) could give maximum grain, biomass and stover yields and a 100% substitution and saving for inorganic P-fertilizer. Therefore, application of 100% of the recommended Orga-fertilizer along with 100% of inorganic N-fertilizers is recommended for better yield return of sorghum in Habru District of Ethiopia and similar agro-ecologies.

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