Journal of Agricultural Science and Food Technology
Vol. 2 (8), pp. 133-138, September, 2016
ISSN: 2465-7522
Full Length Research Paper
http://pearlresearchjournals.org/journals/jasft/index.html

The Effect of Compost Use with Effective Micro-Organisms (EM) On Grain and Biomass Yield of Wheat Cultivated In Tigray, Ethiopia

Gebrejewergs Aredehey* and Daniel Berhe

Accepted 10 October, 2016

Natural Resource Management Directorate, Tigray Agricultural Research Institute, Mekelle, P.O.Box: 492, Ethiopia.

ABSTRACT

Effective Micro-Organisms (EM) has been introduced to Ethiopia for use in several activities, for example, to increase the organic compost quality. However, there are no studies about effects of compost with EM use in Tigray cultivated with wheat. This paper is aimed to evaluate the effect of compost with EM use on productivity of biomass and grain of wheat cultivated on two places of Tigray region (Maimegelta's kebele Farmers Training Center (FTC) and Illala research site). A field experiment designed in randomized complete blocks (RCBD) with three replications was conducted to examine the study. The treatments included: (1) control, (2) recommended chemical fertilizer (100 kg ha^{-1} of urea and 100 kg ha^{-1} of DAP) (3) Compost with EM (5 t ha^{-1}) and compost without EM (5 t ha^{-1}). The variance analysis showed that there was no significant difference among treatments studied at 5% significant level. Although there were no significant differences between treatments studied, the highest increment in wheat grains yield was obtained for treatments with the use of compost with EM. Therefore, in conditions that this study was performed, compost with EM could be used in agricultural soils of these two areas in order to wheat production and to reduce costs with chemical fertilizer use.

Key words: Chemical Fertilizer, Wheat Production, Compost, Dryland Area and Tigray.

*Corresponding author. E-mail: gebre2030@gmail.com. Tel: +251344402801.

INTRODUCTION

Numerous microorganisms are present in soil (Foth, 1990). The microbial life in the soil has a huge importance in weathering and formation of the soil, through the mineralization and immobilization processes of nutrients (Wilding et al., 1983). They also are degradation agents of plant and animal wastes in soils, making nutrients available for plants (Sue et al., 2003). The application of organic fertilizers, such as manure, crop residues and compost, has been practiced for a long time in order to increase the amount of microorganisms present in the soil, soil fertility and agricultural productivity (Mariangela and Francesco, 2010; Cooperband and Wisconsin, 2002). In a study performed by Higa (1991) discovered a group of beneficial microorganisms named EM, this microorganisms contain predominantly populations of bacteria, yeasts, and smaller numbers of photosynthetic bacteria and actinomycetes. The EM can be applied to soil along with compost to improve soil quality, soil health, and the growth, yield, and quality of crops (Higa and Parr, 1994). EM decompose the organic materials releasing beneficial soluble substances such as amino acids, sugars, alcohol, hormones and similar organic compounds that can be easily absorbed by plants (Higa, 1999) Besides this Jusoh et al. (2013) found that compost with EM has higher N, P K, and Fe content as compared to compost without EM after laboratory analysis, and concluded that the application of EM in compost increases the macro and micronutrient content of the soil. Compost with EM enhances soil fertility by reducing soil acidity; pH, salinity; ECe and Na due to the acidic culture of EM and its antioxidizing effect (El-Shafei et al., 2008). Several studies indicated that agricultural use of organic compost with EM addition can significantly increase the grain and biomass production (Lindani and Brutsch, 2012; Ndona et al., 2011; Dehghani et al., 2013).

A long term field experiment had been conducted in China Agricultural University's Qu-Zhou experimental station about the effect of compost with EM use on wheat yield, this study showed that the compost with EM application increased significantly the production of biomass and grain of wheat in comparison to use of compost without EM and the control (Hu and Qib, 2013). EM technology has been used in different countries and a positive effects has been reported by studies performed in field and in laboratory conditions (Javaid and Bajwa, 2011; Shah et al., 2011; Lindani and Brutsch, 2012), due to this some countries has used this technology as part of their national agricultural policy (Higa, 1999). Recently, EM has been introduced to Ethiopia for use in several activities, for example, the EM use for increase the organic compost quality. The use potential of compost with EM for increase the crop productivity has been studied in many countries. Some studies showed positive effect and others indicated negative effects. Studies conducted in Sudan and Switzerland showed that effective microorganisms did not improve in most of the measured parameters of crops and soil quality (Mohammed and Elmustafa, 2014; Mayera et al., 2010; Shah et al., 2011), Whereas, studies conducted in china, Austria, Egypt and Pakistan showed that the use of EM with compost, increased crop production and soil fertility (Hu and Qib, 2013; Ndona et al., 2011; El-Shafei et al., 2008). The Ethiopian government has adopted widely making of compost since the last 25 years. At the moment at least 25% of the farmers are making and using compost in Tigray region and the years between 2003 and 2006, grain yield for the Region almost doubled from 714 to 1,354 thousand tones (Sue et al., 2003). Composting in Ethiopia is becoming the most important agricultural activity, as it reduces the expense for chemical fertilizers and increases the moisture holding capacity of the soil. Thus, the use of EM on organic compost promotes composting practices especially in Tigray region. However, there are not studies about effects of compost with EM use on dryland areas of Tigray, North Ethiopia cultivated with wheat. Thus, studies about the effects of compost with EM use on productivity of wheat cultivated on land areas of Tigray, North Ethiopia, are need in order to promote its agricultural use. This paper aimed to evaluate the effect of compost with EM use on productivity of biomass and grain of wheat cultivated in the dry land areas of Tigray, North Ethiopia.

MATERIALS AND METHODS

Field experiment was conducted at two experimental sites: Mai-Megelta's kebele (peasant association) FTC in Saesie-Tsaedaemba woreda, eastern zone of Tigray and Mekelle Agricultural Research Center (MARC), Illala research site. The first experimental site is located at $14^{0}05'35''$ N, $39^{o}33'50''$ E, and altitude equal to 2504 m. The second experimental site is located at $13^{o}31'24''$ N, $39^{o}30'09''$ E, and altitude equal to 2009 m. In 2013, field experiments were carried out during the rainy season (July to September). The experiment was designed in RCBD with three replications. Three times before of planting and one time in planting occasion, the soil was ploughed using ox-plough, after this, it was done the leveling of the area in order to establish the experimental plots. Each plot had 12 m^2 (3 x 4 m), with following treatments: 1. Control, 2. Recommended chemical fertilization (100 kg ha^{-1} of urea and 100 kg ha^{-1} of DAP), 3. Compost with EM (5 ton ha^{-1}) and 4. Compost without EM (5 ton ha^{-1}). Chemical fertilization was done with urea and Di-ammonium phosphate (DAP), in accordance to the blanket recommendation of fertilization adopted nationally for major cereals in Ethiopia (MoARD, 2009). In treatments with chemical fertilizer use, nitrogen fertilizer was added to plots in two periods: 75% was added in occasion of planting and 25% was added at stem elongation stage. Phosphorous fertilizer and the organic compost with and without EM were added during planting time.

A series of two pits with 1m length, 1m width and 1.5 m depth, one next to the other at each study site were dug for each compost pit with and without EM. The compost pit was filled up with layers of materials: thick materials like dried sorghum and maize biomass at the bottom, followed by weeds and grasses and then by animal manure and soil. The same amount and types of composting materials were used for composting with and without EM. At each layer, a mixture of EM-1, molasses, and distilled water at the rate of 1:2:97, respectively was sprayed to the pit of compost with EM. 90, 1.038 and 22.095 kg ha^{-1} of total nitrogen, available phosphorous and available potassium, respectively was supplied to plots received compost with EM. 70, 0.691 and 19 kg ha^{-1} of total nitrogen, available phosphorous and available potassium was supplied to plots received compost without EM. The seeds and fertilizers were applied equally in all plots, and they were incorporated manually with hoe into a 5 cm soil depth. Wheat seed was sowed at the rate of 150 kg ha^{-1}. In wheat harvest occasion, plant samples were taken of area equal to 2 m^2, in each plot, and production of biomass and grains were quantified 90 days after compost and fertilizer application.

The wheat was harvested above ground, sun dried and weighed before threshing using a hanging weighing balance to take biomass yield of wheat. Harvested wheat was then threshed and the grain yields were measured using a sensitive balance. All data were analyzed by variance analysis (ANOVA) using SAS software package version 9.0.

Table 1. ANOVA table for biomass yield in Mekelle Agricultural Research Center, Illala research site.

Source	Degree of freedom	Sum of squares	Mean squares	F value	Tabular F (5%)
Total	11	75878786.67			
Replication	2	23104985.17	11552492.58		
Treatment	3	36286526	12095508.67	4.4ns	9.78
Error	6	16487275.5	2747879.25		

ns = not significant.

Table 2. ANOVA table for grain yield in Mekelle Agricultural Research Center, Illala research site.

Source	Degree of freedom	Sum of squares	Mean squares	F value	P value
Total	11	5676809.667			
Replication	2	2057785.167	1028892.58		
Treatment	3	2875862.33	958620.77	7.74ns	9.78
Error	6	743162.167	123860.36		

ns = not significant.

Table 3. ANOVA table for biomass yield in Mai-Megelta's kebele (peasant association) FTC.

Source	Degree of freedom	Sum of squares	Mean squares	F value	Tabular F (5%)
Total	11	38394091.67			
Replication	2	18068516.67	9034258.33		
Treatment	3	16672691.67	5557563.89	9.13ns	9.78
Error	6	3652883.33	608813.89		

ns = not significant.

Table 4. ANOVA of grain yield in Mai-Megelta's kebele (peasant association) FTC.

Source	Degree of freedom	Sum of squares	Mean squares	F value	Tabular F (5%)
Total	11	2485966.66			
Replication	2	830516.66	415258.33		
Treatment	3	1139233.33	379744.44	4.41ns	9.78
Error	6	516216.66	86036.11		

ns = not significant.

RESULTS AND DISCUSSION

The variance analysis (Tables 1 to 4) showed that there was no significant difference among treatments studied at 5% significant level in both grain and biomass production at all experimental sites. The application of compost with EM did not increase significantly the production of biomass and grain of wheat in comparison to the use of compost without EM and the control. This result is contradicted with findings of Hu and Qib (2013) that the compost with EM application increased significantly the production of biomass and grain of wheat in comparison to use of compost without EM and the control. Whereas, this result has similarity with the study performed by Jamilu and Samina (2013), that growth and yield reaction of wheat to effective microorganisms and parthenium green manure did not significantly increased the various plant growth and yield parameters. Mayera et al. (2010) also reported that EM could not improve yields and soil quality after 4 years of application in field experiment under temperate climatic conditions of Central Europe. Although there were no significant difference between treatments studied, Tables 5 and 6 showed that highest increment in wheat grains yield was obtained for treatments with the use of compost with EM in comparison to chemical fertilizer application at both experimental sites.

The application of compost with EM increase the wheat grain yield by 65%, in Mai-megelta's FTC (Figure 2) and by 79% in Mekelle Agricultural Research Center (Figure 1) over the control. Whereas the chemical fertilizer application increased the wheat grain yield by 45% in Mai-megelta's FTC and by 65% in Mekelle Agricultural Research Center over the control. This result has similarity with result of Jamilu and Samina (2013), and found that

Table 5. Treatment means for biomass and grain yield in Mekelle Agricultural Research Center, Illala research site.

Treatments	Treatment means	
	Biomass yields (kg ha^{-1})	Grain yield (kg ha^{-1})
Control	5836	1593
100kg/ha urea and 100kg/ha DAP	9485	2631
EM compost	10441.67	2865.66
Compost without EM	9200	2597.66
Total	34962.67	9687.32
Mean	8740.667	2421.83

Table 6. Treatment means of biomass and grain yield Mai-Megelta's kebele (peasant association) FTC.

Treatments	Treatment means	
	Biomass (kg ha^{-1})	Grain yield (kg ha^{-1})
Control	6416.6	1300
100kg/ha urea and 100kg/ha DAP	9633.3	1886.6
EM compost	8766.6	2150
Compost without EM	8120	1816.6
Total	32936.5	7153.2
Mean	8234.12	1788.3

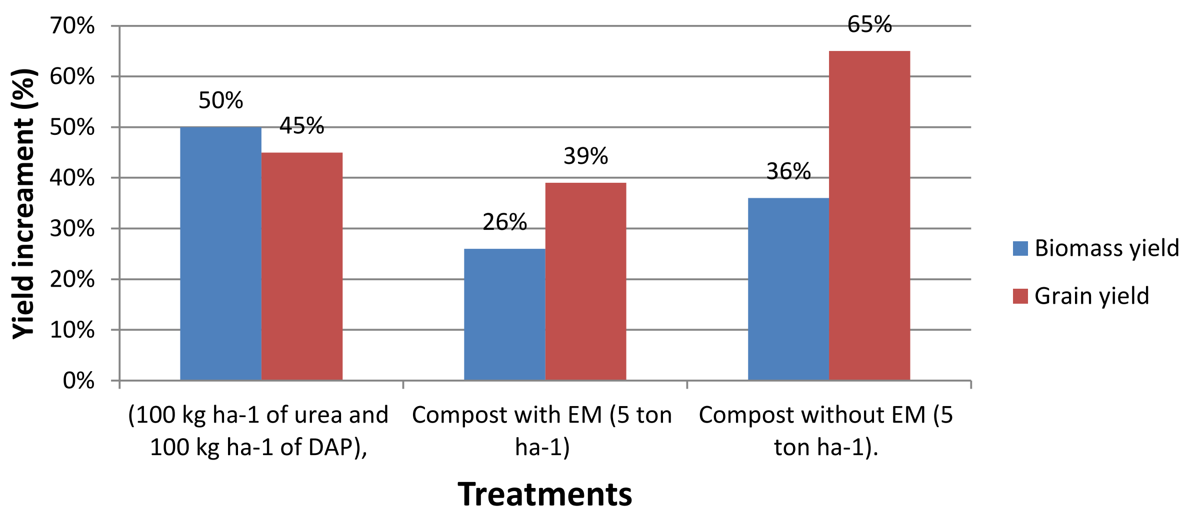

Figure 2. Increments percentages obtained for biomass and grain productions in comparison to control, for the experiment conducted in Maimegelta research site.

the application of 4% parthenium green manure with EM increased in shoot dry biomass of wheat by 272% and the application of recommended dose of nitrogen-phosphorus-potassium (NPK) fertilizer increased by 137% over the control. This is due to the ability of stimulating the mineralization of nutrients when the EM is integrated with organic materials like compost (Fatunbi and Ncube, 2009). Moreover, as the study site is drought prone area, the addition of compost to a soil increases the mean water holding capacity of a soil (Vengadaramana et al., 2012) and this could have an effect on the production of wheat grain. Therefore, in conditions that these study was performed, compost with EM could be used in agricultural soils of these two areas in order to wheat production and to reduce costs with chemical fertilizer use, besides this, the long term compost use can reduce the negative impacts from chemical fertilizer excessive application.

CONCLUSION

The variance analysis showed that there was no significant difference among treatments studied at 5% significant level. Despite this, in comparison to control, there was a

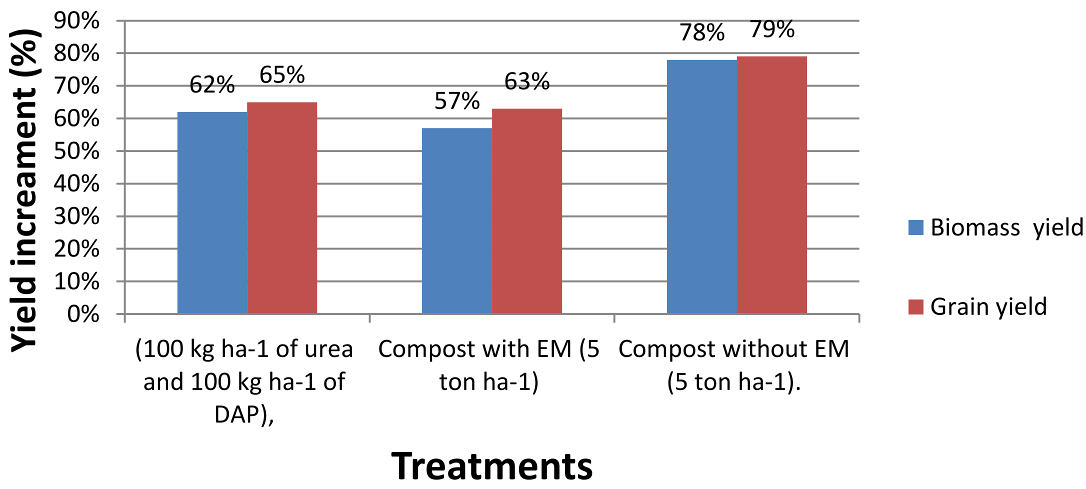

Figure 1. Increments percentages obtained for biomass and grain productions in comparison to control, for the experiment conducted in Illala research site.

higher increment in wheat grain yield due to compost with EM application in comparison to increments obtained for chemical fertilizers use at both experimental sites. Therefore, in conditions that this study was performed, the compost with EM use could improve the grain yield of wheat cultivated in the dry land areas of Tigray, North Ethiopia. Thus, long term studies should be conducted in order to evaluate others benefits due to use of compost with EM ; such as possible improvements in soil properties, and too in order to quantify the economic and environmental benefits of this use. And thus, it divulge among the local farmers an agriculture more sustainable able to reduce the poverty.

ACKNOWLEDGMENTS

We would like to express our sincere gratitude to Tigray Agricultural Research Institute (TARI) for providing us financial support to accomplish the experiment.

REFERENCES

Cooperband L, Wisconsin M (2002).Building Soil Organic Matter with Organic Amendments. Center for Integrated Agricultural Systems (CIAS), College of Agricultural and Life Sciences, University of Wisconsin-Madison.

Dehghani I, Kordlaghari K, Mohamadinia G (2013). Effect of effective microorganisms activate (EMa) on growth, yield and yield. Annals Biol. Res. 4(4): 126-129.

El-Shafei A, Yehia M, El-Naqib F (2008). Impact of effective microorganisms compost on soil fertility and rice productivity and quality. Misr J. Ag. Eng., 25(3): 1067- 1093.

Fatunbi AO, Ncube L (2009). Activities of Effective Microorganism (EM) on the Nutrient Dynamics of Different Organic Materials Applied to Soil. Am-Euras. J. Agron., 2(1): 26-35.

Foth HD (1990). Fundamentals of soil science. 8th Edn., John Wiley & Sons.Inc., USA.

Higa T (1991).Effective microorganisms: A biotechnology for mankind. First international conference on Kyusei nature farming, Washington DC, USA, October 17-21, 1989, pp.8-14.

Higa T (1999). Application of Effective Microorganisms for Sustanable Crop Production. University of the Ryukyus, Okinawa, Japan.

Higa T, Parr J (1994). Microorganisms for sustainable agriculture and environment. International Nature Farming Research Center. Atami, Japan.

Hu C, Qib Y (2013). Long-term effective microorganisms application promote growth and increase yields and nutrition of wheat in China. Europ. Agron., 46(2013): 63- 67.

Jamilu T, Samina F (2013). Growth and yield reaction of wheat to Effective Microorganisms and parthenium green manure. Int. J. Manures Fertilizers 2(5): 315-322.

Javaid A, Bajwa R (2011). Field evaluation of eff ective microorganisms (EM) application. Turk J. Agric. For., 35(2011): 443-452.

Jusoh ML, Manaf LA, Latiff PA (2013). Composting of rice straw with effective microorganisms (EM) and its influence on compost quality. Iranian J. Envi. Health Sci. Eng., 10(17): 1-9.

Lindani, N. & Brutsch, M. (2012). Effects of the integrated use of effective micro-organisms, compost and mineral fertilizer on greenhouse-grown tomato. Afr. J. Plant Sci., 6(3): 120-124.

Mariangela D, Francesco M (2010). Long-term effects of organic amendments on soil fertility. A review. Agron. Sustain. Dev., 30(2010): 401-422.

Mayera J, Scheida S, Widmera F, Fließbachb A, Oberholzera H (2010). How effective are 'Effective microorganisms (R) (EM)'? Results from a field study in temperate climate. Appl. Soil Ecol., 4(1): 37-54.

MoARD (2009).Environment and Social Assessment Fertilizer Support Project. Addid Abeba.

Mohammed T, Elmustafa Elsheikh E (2014). Response of groundnut and faba bean to organic chemical and microbial fertilizers inthree types of soils in Sudan. Int. J. Sudan Res., 4(1): 37-54.

Ndona RK, Friedel JK, Spornberger A, Rinnofner T, Jezik K (2011). ‘Effective Micro-organisms’ (EM):An effective plant strengthening Agent for Tomatoes in Protected Cultivation. Biol. Agric. Hort., 27: 189-204.

Shah S, Saleem F, Shahid M (2011). Effect of Different Fertilizers and Effective Microorganisms on Growth, Yield and Quality of Maize. Int.J. Agric. Biol., 3(4): 378-379.

Sue E, Asmelash A, Araya H, Gebreegziabher T (2003). The Impact of Compost Use on Crop Yields in Tigray, Ethiopia. Third World Network, Penang, Malaysia.

Vengadaramana A, Jashothan , PTJ (2012). Effect of organic fertilizers on the water holding capacity of soil in different terrains of Jaffna peninsula in Sri Lanka. J. Nat. Prod. Plant Resour., 2(4): 500-503.
Wilding LP, Smeck NE, Hall GF (1983). Pedogenesis and soil taxonomy. Elsevier Science Publishers B.V., Netherlands.