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Effect of Compost in Improving Soil Properties and Its Consequent Effect on Crop Production –A Review

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Abstract
Organic fertilizers are an alternative environment friendly approach with multi-advantages over chemicals, seems promising to support sustainable agriculture. This paper aimed to review the indigenous experience on agronomical uses of organic manure and its potential role in agricultural development. It is clear that, organic manures from different plant and animal sources are available to meet some requirements in the field. Nevertheless, organic manures have not been well appreciated in agricultural strategy, so their use remains mostly traditional. Direct application of bulky Organic manures to soil causes rate of mineralization and the rate of release of nutrients particularly of the nitrogen is low. Composting of these wastes seems to have great prosperities compared to raw materials, which have little value and some drawbacks. Most of investigators confirmed that compost application could improve the physical, chemical and biological characteristics, soil organic matter, and nutrient status of the soils. All long-term compost application trials result in increased SOM concentrations. However, mature composts increase SOM much better than fresh and immature composts due to their higher level of stable carbon. In addition, due to its multiple positive effects on the physical, chemical and biological soil properties, compost contributes to the stabilization and increase of crop productivity and crop quality. Consequently, most investigators proved that compost has an equalizing effect of annual/seasonal fluctuations regarding water, air and heat balance of soils, the availability of plant nutrients and thus the final crop yields. Predominantly because of the slow release of nutrients and its availability in compost-combined fertilization schemes often show good results. Thus, for sustainable agricultural systems within small-scale farming in developing countries like Ethiopia, composting can be a good option for developing effective plant-nutrient management strategies in many situations.
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1. INTRODUCTION

Application of un-decomposed wastes or non-stabilized compost to land may cause phytotoxicity due to insufficient biodegradation of organic matter (Maria and Abdalla, 2017), besides the risk of containing harmful organisms or pathogenic microbes (Noble and Roberts, 2004). Addition of high C/N residues will deplete the soil's supply of soluble nitrogen, causing plants to suffer from nitrogen deficiency (Brady and Weil, 2016). To make more effective organic residue should decomposed to form stable C/N. During the composting process, the C/N ratio of organic materials in the pile decreases until a fairly stable ratio, in the range of 10:1–20:1, is achieved (Brady and Weil, 2016).

Composted organic material is being applied on agricultural fields as an amendment to provide nutrients and also to enhance the organic matter content and improve the soil properties of the cultivated soils (Mohammed *et al*., 2004). In addition, compost can solve the problem faced on farmers with decreasing fertility of their soil. Due to soil fertility problems, crops yields often decrease and the crops are more susceptible to pest and disease because they are in bad condition (Madeleine *et al*., 2005).

Compost consists of the comparatively stable decomposed organic materials resulting from the accelerated biological degradation of organic materials under controlled, aerobic conditions (Paulin and Peter, 2008). Compost is made from plant and animals remains with the objectives of recycling plant and animal's remains for crop production (Duong, 2013). The decomposition process converts potentially toxic organic matter into a stabilized state that can improve soil for plant growth (Bastida et al., 2010). Composted organic materials has other beneficial effects, including diverting landfills wastes to alternative uses, removal of pathogen inocula or weed seeds and decomposition of petroleum, herbicide or pesticide residues, erosion control and as a nutrient source for sustainable re- vegetation of degraded soils. Using compost can improve the capacity to produce safe 'clean green' horticultural produce and importantly increase the potential for large-scale organic food production (Paulin and Peter, 2008).

Soil organic matter is of crucial importance for maintaining soil quality by improving biological, physical and chemical soil conditions (Haile, 2017).Thus, compost is a good organic fertilizer because it contains nutrients as well as organic matter. In addition, organic matter makes its greatest contribution to soil productivity. Compost offers nutrients to the soil, increases its water holding capacity, and helps the soil to maintain good tilth and thereby better aeration for germinating seeds and plant root development (Edwards and Hailu, 2011).

Furthermore, soil fertility is linked with mineralization of nutrients contained in organic matter and their release in plant- available form to the soil solution. Mineralization is the result of normal biological cycles within the soil and can be stimulated by the addition of appropriate quality compost and cultivation (Paulin and Peter, 2008). Because mineralization occurs over extended periods it can make important contribution to plant growth and to minimizing the impact of leaching associated with rainfall and excess irrigation (Paulin and Peter, 2008). On the other hand, adding artificial fertilizer alone is not sufficient to retain a sufficient level of soil fertility (Getachew *et al*., 2014). Organic matter is needed to retain the water and nutrient. In degraded soil, where there is little organic matter, yields response is limited, even if artificial fertilizer are being used (Madeleine *et al*., 2005). Hence, the farmers need to take care of the organic matter content of the soil. An integrated approach, combing application of compost with an application of artificial fertilizer is a good strategy for sustainable crop production (Gete *et al*., 2010).

In Ethiopia soil erosion and declining of fertility is a serious problem to agricultural productivity and economic growth (Gete *et al*., 2010). The average annual soil erosion rate nationwide was estimated at 12 ton/ha, giving a total annual soil loss of 1,493 million tons (EPA, 2012). Hence, to sustain the balance of soil fertility and reduce soil erosion, and to ensure agricultural productivity adoption of composting technology and application of amenable compost is quite essential. Therefore, the objective of this paper is to review the influence of compost on soil properties, and its effect on crop productivity.

Discussion

Organic Fertilizer

Organic manures are organic materials derived from animal and plant wastes or byproducts, and they contain plant nutrients in complex organic form (Krishan, 2005). Their addition to agricultural soil increases the organic matter content, the population of soil organisms, especially some bacteria, the activities of some soil enzymes such as urease and the capacity of the soil to bind moisture and deters insects and weeds (Sneh *et al*., 2005). Maria and Abdalla (2017) reported that, organic manures act as a reservoir of plant nutrients and prevent nutrient leaching by maintaining a high cation exchange capacity, as well as buffering growing plants against sudden changes in their chemical environment.

However, if fresh organic matter with a C/N (proportion of percentage of carbon to that of nitrogen) of greater than 30 is added to a soil, there is immobilization of nitrogen during the initial decomposition process (Krishan, 2005). Bulky organic residue contains slow release nutrients, which benefit both the present and the following crop (Verma, 2008). For that reason, besides their inherent low nutrients contents, organic manures must be decomposed in order to sustainably maintain soil at optimum level of fertility and productivity.

Compost

Composting of organic wastes is a bio oxidative process involving the mineralization and partial humification of the organic matter, leading to a stabilized final product (compost), free of phytotoxicity and pathogens and with certain humic properties (Krishan, 2005). As a result, compost is a dark crumbly and earthy-smelling form of decomposing organic matter. The process of composting is related to the concept of sustainable development and increases circular flow of production from the linear systems (raw material is used for the products, byproducts and waste) to the circular systems (waste is re-used as energy or raw material for another product or process) (Vemic *et al., 2014*).

Role of compost on soil physical properties

Reduction of bulk density

Compost application generally influences soil structure in a beneficial way by lowering soil density due to the mixture of low density organic matter into the mineral soil fraction (Brown and Cotton, 2011). This positive effect has been detected in most cases and it is typically associated with an increase in porosity because of the interactions between organic and inorganic fractions (Amlinger *et al*., 2007). Brown and Cotton (2011) have observed that soil bulk density followed a predictable pattern with decreased bulk density at increasing rate of compost (Figure 1).

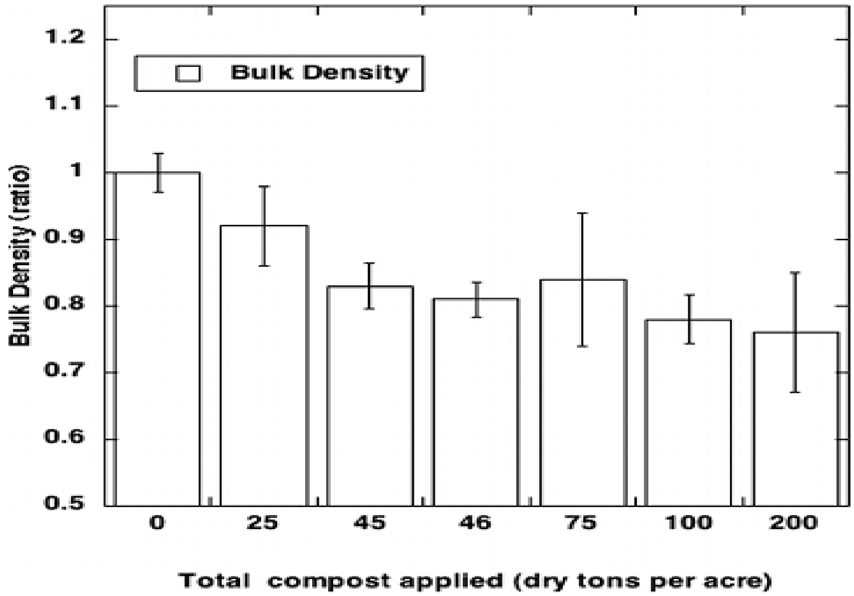

Figure1. Soil bulk density in compost amended soils and control (Brown and Cotton, 2011). Values <1 indicates reduced bulk density in comparison to the control soils.

Low bulk of density indicates increased pore space and is indicative enhanced soil tilth. In this respect, compost increases the portion of macro and micro-pores because of an improved aggregation and stabilization of soil significantly initiated by various soil organisms (Liu *et al*., 2007). In addition, the organic fraction is much lighter in weight than the mineral fraction in soils. As the result, increases in the organic fraction decrease the total weight and bulk density of the soil (Brown and Cotton, 2011).

Improving aggregate stability

In general, soil structure is defined by size and spatial distributions of particles, aggregates and pores in soils. By incorporation of compost into the soil, aggregate stability increases most effectively in clayey and sandy soils (Tejada *et al*., 2009). Positive effects can be expected by well humified (promoting micro-aggregates), as well as fresh, low-molecular OM (promoting macro-aggregates). Macro aggregates are mainly stabilized by fungal hyphen, fine roots, root hair and microorganisms with a high portion of easily degradable polysaccharides (Amlinger *et al*., 2007).

According to Bouajila and Sanaa (2011), application of manure and household wastes compost resulted in significant increase of structural stability, with the compost treatment being the most efficient (Figure 2). Their results also indicated that the application of 120 t/ha household wastes and manure improved better the structural stability when compared with control. Such behavior might be the result of raised organic matter content and important microbial activities (Amlinger *et al*., 2007).

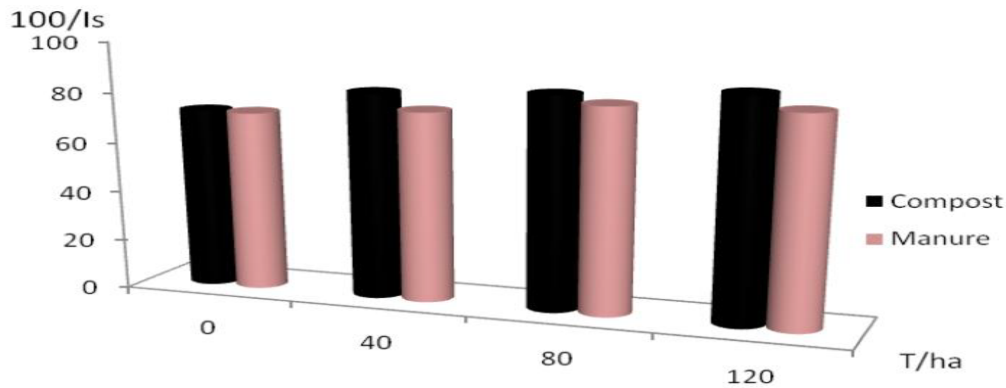

Figure 2: Changes in the structural stability in amended parcels with manure and compost (Bouajila and Sanaa, 2011)

Besides, aggregate and pore properties of soils are associated with specific "active" surface area influencing several storage and exchange processes in soil. The higher the specific surface area, the more intensive interactions can occur between soil fauna, microorganisms and root hairs under optimum conditions (e.g. sufficient humidity). As a result, a high specific surface area can create the prerequisite for an optimal soil formation (Amlinger *et al*., 2007).

Improve water availability and retention

Composts are used in agriculture to improve soil fertility and quality because they can increase organic matter content, especially in sandy soils, which have low water and nutrient holding capacity (Laila, 2009). Field capacity and available water holding capacity are generally influenced by the particle size, structure and content of OM. However, clay soils, due to higher matric potential and smaller pore size will generally hold significantly more water by weight than sandy soils. In this respect, Brown and Cotton, (2011) have showed that while overall, texture is the primary factor affecting water holding capacity, increasing organic carbon is a significant factor for improving soil water holding capacity. The authors confirmed that compost application had the greatest effect on soil water holding capacity on coarser textured soils with smaller to no change in water holding capacity on finer textured soils. Further they have observed the effect of compost addition on soil infiltration rate. Across all soils, compost addition increased water infiltration rate compared to the control (Figure 3).

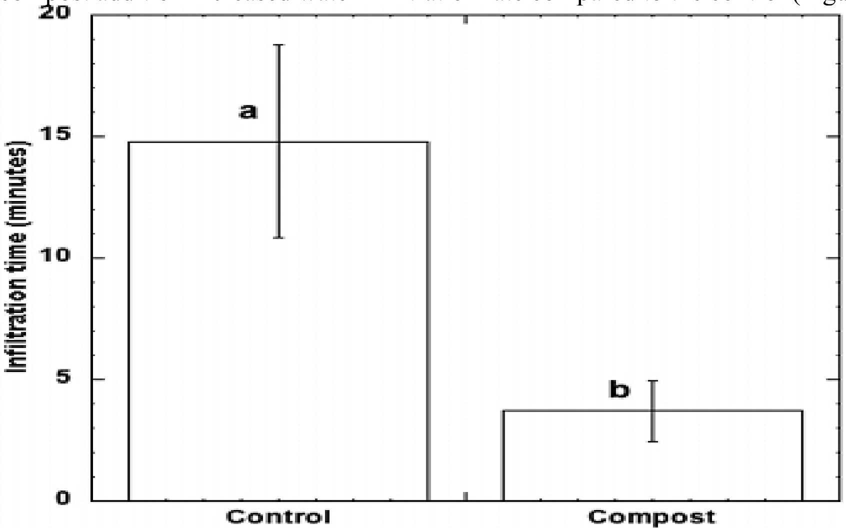

Figure 3. Water infiltration (minutes) for all compost amended and control soils with the same soil series (Brown and Cotton, 2011).

Other authors (Bouajila and Sanaa, 2011) reported that the application of 120 t/ha household wastes compost and manure improved water infiltration (549.25 and 596.46 cm, respectively) when compared with control (332.16 cm). Additionally, increased infiltration is another indication of increased efficiency in water use as a higher fraction of irrigation or rainfall is likely to enter soils with higher infiltration rates. More rapid infiltration is associated with reduced runoff, better aeration, and improved irrigation efficiency (Daniel and Bruno, 2012). Similarly, composted cattle manure applied to the soils showed a positive effect, improving infiltration and decreasing runoff volumes by up to 20% (Ramos and Marttinez , 2006).

Mohammad *et al.* (2004) reported that as the compost application rates were increased from 0 tons/ha to 48.5 tons/ha the soil moisture content were also increased indicating a considerable improvement in water availability. Brown and Cotton (2011) proved that soil's retaining ability correlates positively with soil organic matter content and negatively with soil density. Their result showed that the treated soil increased water holding capacity by about 1.57 times that of the control soils.

Additionally, reduced erosion is mainly related to the improved soil structure by the addition of compost, which, in turn, is pointed out by better infiltration rate, pore volume and enhanced stability through aggregation. According to Amlinger et al. (2007), experimental trials showed a clear correlation between increases of SOM, reductions of soil density, soil loss and water run-off. Strauss (2003) has quantified the effect of compost on soil erosion in detail. Five years long compost application resulted in 67% reduced soil erosion, 60% reduced run-off, and 8% lower bulk density and 21% higher OM content compared to control plots.

Role of compost on soil chemical properties

Improve soil organic matter

Most essential nutrients in compost are in organic forms which are released slowly and are less subject to leaching compared to inorganic fertilizers (Larney *et al.*, 2008). The incorporation of compost derived from biogenic household and garden waste to soils increases soil carbon and total nitrogen concentrations (Mylavarapu and Zinati, 2009). Whalen *et al.* (2008) reported that, after 5 years of annual addition of compost derived from cattle manure, organic carbon and total nitrogen concentrations were increased by up to 2.02 ton $ha^{-}1\ yr^{-1}$ and 0.24 ton $ha^{-1}\ yr^{-1}$ respectively. Compared to manure or fresh plant residues, compost carbon is poorly decomposable; thus compost may be useful to increase carbon sequestration in soils. Lynch (2006) showed that two years after the last application of compost from dairy manure and sewage sludge , 37-67 % of applied carbon was still retained in the soil, with 19-34 % of soil carbon derived from compost, compost carbon is mainly stored in macro- aggregate (Lee *et al*., 2009).

There are few trials, which show no significant differences in SOM level by the application of diverse C sources (straw, manure, compost). However, the majority of studies of different authors have definitely confirmed a better humus reproduction for composted materials (Agegnehu *et al*., 2014 and Amlinger *et al*., 2007). According to Amlinger *et al*., 2007, the average SOM demand of agriculturally used soils can be met by applying 7 – 10 Mg (dry matter) compost ha^{-1}. Therefore, for a long-term increase of SOM, more than 10 Mg dry matter compost ha^{-1} is required.

Enhancement of nutrient concentration

The application of compost from municipal solid waste (MSW) and dairy manure to soils can result in a significant increase in concentrations of N, P, K, Ca, Mg and S as well as a variety of essential trace elements in soil (Butler *et al*., 2008). Its nutrient content as well as other important chemical properties like C/N ratio, pH and electrical conductivity (EC) depends on the used organic feedstocks and compost processing conditions. By an appropriate mixture of these, organic input materials, humus and nutrient-rich compost substrates can be produced which serving as a substitute for commercial mineral fertilizers in agriculture (Amlinger *et al*., 2007). However; their diverse beneficial properties for amelioration outreach their nutrient content.

Soheil *et al*. (2012) determined the effects of Municipal Waste Compost (MWC) on soil chemical properties and corn plant responses in pot experiment. They found that the amount of available N, P and K and micronutrient concentrations in soil increased as the result of waste compost application (Table 1). The increases were significant for all concentrations, especially for 60 ton ha^{-1} treatment. They also tested the concentrations of N, P, K and micronutrient elements in the dry matter of the aerial part of the plant (Table 2). The result showed that N, P and K content and concentration of micronutrients in plant increased with increase of compost concentration. Amount of the waste compost was significantly increased concentrations of macro and micronutrients in dry matter; also, they had significant effects on concentrations of heavy metals. However, the content of concentration of cations was higher in plants exposed to 60 ton ha^{-1} to 4 Kg soil compost concentration than the rest concentrations and control.

According to Soheil *et al*. (2012) research results, the application of large quantities of MWC may contaminate soils with heavy metals or other toxic elements. Significant differences were observed between treatments and the treatment 60 ton ha^{-1} has shown highest effects on soil and corn properties. However, to apply these kinds of fertilizers we should notice the quantity and available forms of heavy metals and their additive effects on soils and plants like corn and also we should notice the excessive quantity of elements and their toxicity and salinity to soils and plants yield like corn and use favorable managements. In general, the content of several ions in the compost is of potential nutritional value to plants, especially when the heavy metals content are low, but high concentrations of some ions can potentially increase salinity soils (Soheil *et al*. (2012).

In another study, Brown and Cotton (2011) suggested that compost amended soils contain comparable concentrations of plant available nutrients compared to conventionally fertilized soils and elevated concentrations of macro- and micronutrients in comparison to control soils. Gamal (2009) has also conducted the experiment by applying 0 ton, 5 ton, and 10 ton ha^{-1} rates of compost and tested the nutrient content at harvest. He observed increased N, P and K nutrients content in all compost received plots and this increase was higher in plots receiving 10 ton ha^{-1} of compost. With respect to micronutrients, increased uptake of Cu, Mn and Zn were reported (Amlinger *et al*., 2007). Bouajila and Sanaa (2011) have also reported that the application of increasing manure and waste household compost concentrations (40 and 120 ton ha^{-1}) resulted in significant increase of organic nitrogen (Figure 4).

However, total nutrient content of compost is not plant-available fully at once. This can be attributed to the existence and different intensity of various binding forms within the organic matrix, which result in a partial immobilization of nutrients (Tayebeh et al., 2010). On the other hand, the fertilization effect will last longer due to a slow and gradual release of plant nutrients (Seran *et al*., 2010). Therefore, with compost there is a much better protection from leaching compared to soluble mineral fertilizers. Especially the N fertilization effect of compost is limited due to low mineralization rates and microbial immobilization (Tayebeh *et al*., 2010).

Table 1: The effects of MSW on concentrations of macro, micronutrients and yield in corn

Treatment	mean stem height	Dry matter	Concentration (%)			Concentration (mg kg^{-1}DM)				
t ha^{-1}	Cm	(g)	N	P	K	Fe	Mn	zn	Cu	Pb
Control	31d	3.6^{d}	3^{c}	0.1^{d}	1^{d}	140^{c}	97^{d}	13.5^{c}	55^{d}	0.2^{d}
15	38.7^{c}	6.2^{c}	3.4^{c}	0.2^{c}	1.2^{c}	166^{c}	105^{c}	14.5^{b}	61^{c}	1.9^{c}
30	44.5^{b}	6.8^{b}	4.5^{b}	0.3^{b}	1.4^{b}	256^{b}	129^{b}	14.7^{ab}	68^{b}	3.3^{b}
60	49.2^{a}	7.3^{a}	5.3^{a}	0.37^{a}	1.6^{a}	517^{a}	134^{a}	14.9^{a}	71^{a}	5.1^{a}

Means with common letter in each column are not significantly different at $p<0.05$ according to Duncan Multiple Range Test (Soheil *et al*., 2012)

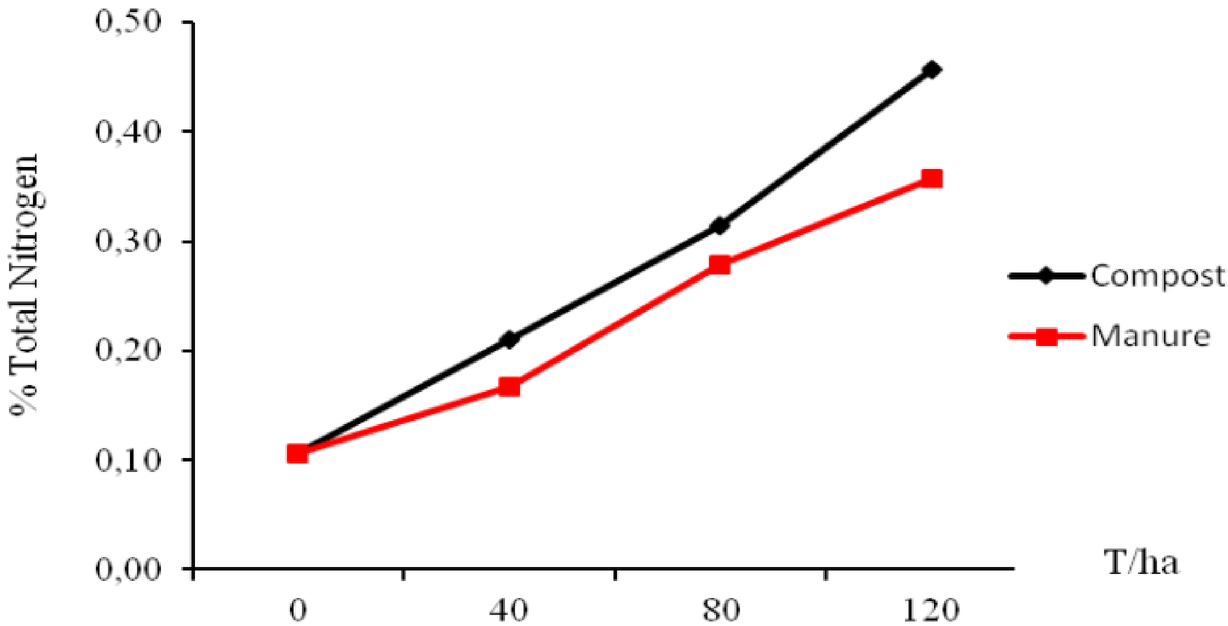

Figure 4. Variations in the total nitrogen percentage in soils amended with manure and compost (Bouajila and Sanaa, 2011)

Increase of Cat ion Exchange Capacity

Composts have a high cation exchange capacity due to input of stabilized OM being rich in functional groups into soil and can therefore increase soil CEC when incorporated (Agegnehu *et al*., 2014 and Duong, 2013). Humic acids, major components of compost can bind cations because they contain carboxylic acid groups, which can bind positively charged multivalent ions (Mg^{2+}, Ca^{2+}, Fe^{2+}, Fe^{3+} and trace elements) (Pedra *et al*., 2008). In Mohammad *et al*. (2004) study, following the first harvest from dry season the same plots were used for re-planting during the wet season.

Data obtained from the second trail indicated that as the compost application rates were increased from 0 tons ha^{-1} to 48.5 tons ha^{-1} the soil CEC as one of the major soil quality indexes were also increased (Table 2) indicating a considerable improvement in nutrient exchange capacity of the soils treated with organic matter amendments. According to Amlinger *et al*. (2007), soil organic matter contributes about 20 – 70% to the CEC of many soils. In absolute terms, CEC of organic matter varies from 300 to 1,400 cmolc kg^{-1} being much higher than CEC of any inorganic material.

Table 2. Soil physical and chemical properties improved by different treatment from the 2nd trail during the wet season (August - October, 2003)

Treat	pH	OM (%)	Db (g/cm3	Ca	Mg	K	$N0_3$	P	CEC(Meq/ 100g)
				Mg/kg					
0 t/ha	7.6	3.4	1.03	3178.6	625.6	217	13.1	17.8	2.17
12.1 t/ha	7.8	4.6	0.98	3300.6	1018.9	485.4	40.5	35.8	2.62
24.2 t/ha	7.8	5.4	1.02	3495.1	1564.6	748.5	55.5	44.6	3.24
48.5 t/ha	7.9	7.2	1.01	4312.1	2072.4	1065	76.7	58.4	4.16

Source: Mohammad et al. (2004)

Increase of pH value, liming effect and improved buffering capacity

Soil pH is an indicator for soil acidity or soil alkalinity and is defined as the negative logarithm of hydrogen ions activity in a soil suspension. It is important for crop cultivation because many plants and soil organisms have a preference for slight alkaline or acidic conditions and thus it influences their vitality. In addition, pH affects availability of nutrients in the soil. Compost application has a liming effect due to its richness in alkaline cations such as Ca, Mg and K, which were liberated from OM due to mineralization (Agegnehu *et al*., 2014 and Daniel and Bruno, 2012). Similarly, regular applied compost material maintains or enhances soil pH (Jamal, 2009 and Soheil *et al*., 2012). Only in some few cases, a pH decrease was observed after compost application (Jamal, 2009 and Soheil *et al*., 2012). Only in some few cases, a pH decrease was observed after compost application.

Role of Compost on soil biological properties

One of the most important effects of compost use is the promotion of soil biology. The addition of compost to soils affects soil microorganisms directly by providing a source of nutrients and indirectly by changing chemical and physical soil properties. Compost stimulates microbial growth and activity, but not to the extent as fresh plant residues because it is already decomposed. Compost generally increases the abundance of soil organisms including earthworms (Sutton-Grier *et al*., 2010).

Addition of compost from various feed stocks has been shown to increase the abundance of Gram-positive bacteria (Islam *et al*., 2009), the density of ammonia oxidixers and denitrifiers in soil (Bastida *et al.*, 2008), as well as soil respiration, the activity of various enzymes and potential nitrification and denitrification (Sutton-Grier *et al*., 2010). These changes will affect nutrient availability to plants and nutrient movement in soils.

Changes in microbial activity and community structure after compost application can lead to increased suppresion of soil-borne plant pathogens (Lozano *et al*., 2009) and enhance degradation of organic pollutants such as polycyclic aromatic hydrocarbons (PAHs) and fuel oil(Yuan *et al*., 2009). However, the effects of compost application on soil microbes may be temporary. Crecchio (2001) reported that two years after addition of compost from MSWs the bacterial community composition was similar to that in unamended due to the depletion of substrate added with the compost.

Role of compost on crop productivity

Due to its multiple positive effects on the physical, chemical and biological soil properties, compost contributes to the stabilization and increase of crop productivity and crop quality (Tayebeh *et al*., 2010). Long-term field trials proved that compost has an equalizing effect of seasonal fluctuations regarding water, air and heat balance of soils, the availability of plant nutrients and thus the final crop yields (Amlinger *et al*., 2007). For that reason, a higher yield can be expected compared to pure mineral fertilization. Better crop results were often obtained if during the first years higher amounts of compost were applied every 2nd to 3rd year than by applying compost in lower quantities of < 10 Mg (DM) ha^{-1} every year (Amlinger *et al*., 2007). However, crop yields after pure compost application were mostly lower when compared to mineral fertilization (Amlinger et al., 2007), at least during the first years. This can be explained by the slow release of nutrients (especially N) during mineralization of compost.

Mohammed *et al*. (2004) has compared the use of composted organic wastes as alternative to synthetic fertilizers for enhancing crop productivity and agricultural sustainability in two season (wet and dry). Yield results from the dry season trail showed gradual increase in crop yield as compost application rate was increased from 0 tons ha^{-1} (control) to 48.5 ton ha^{-1} of compost application (Figure 5). Data from the second corn harvest of 2003 showed considerable yield increase (Figure 6) as the result of increased compost application rates on soils under treatment. However, 48.5 ton ha^{-1} of composted application rate in wet season showed decreased in yield as compared with 12.2 ton ha^{-1} of compost applied. This was an indication that additional application inhibited the grain production probably due to luxurious green vegetative growth that was observed during the growing season (Mohammed *et al*., 2004).

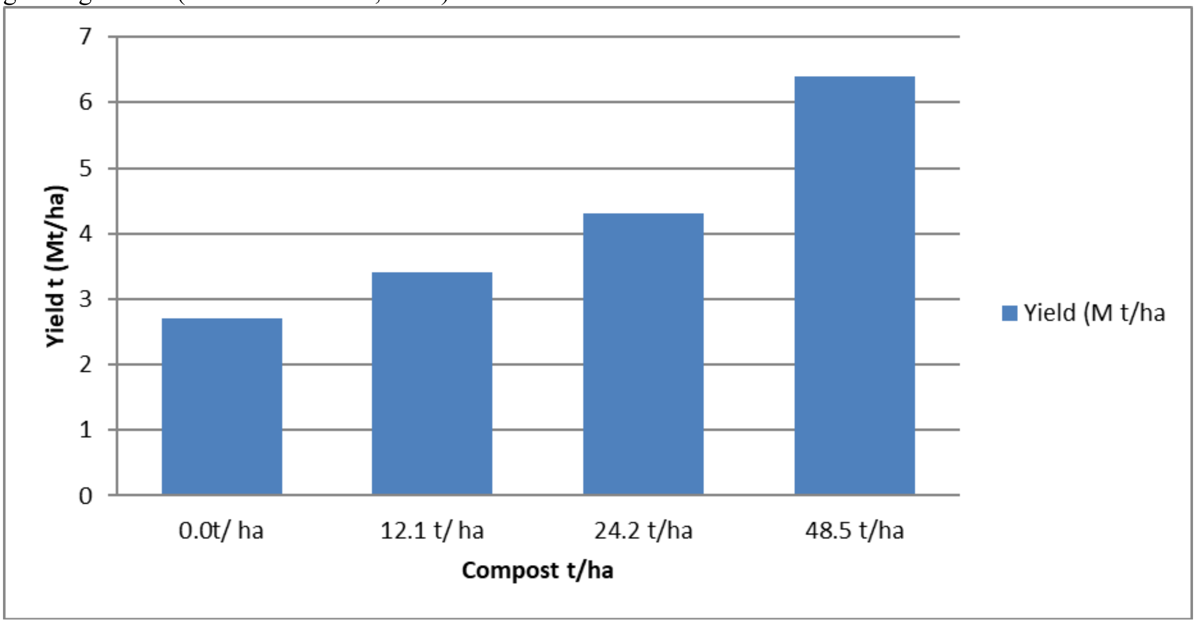

Figure 5.Yield results from the dry season trial (Mohammad *et al*., 2004).

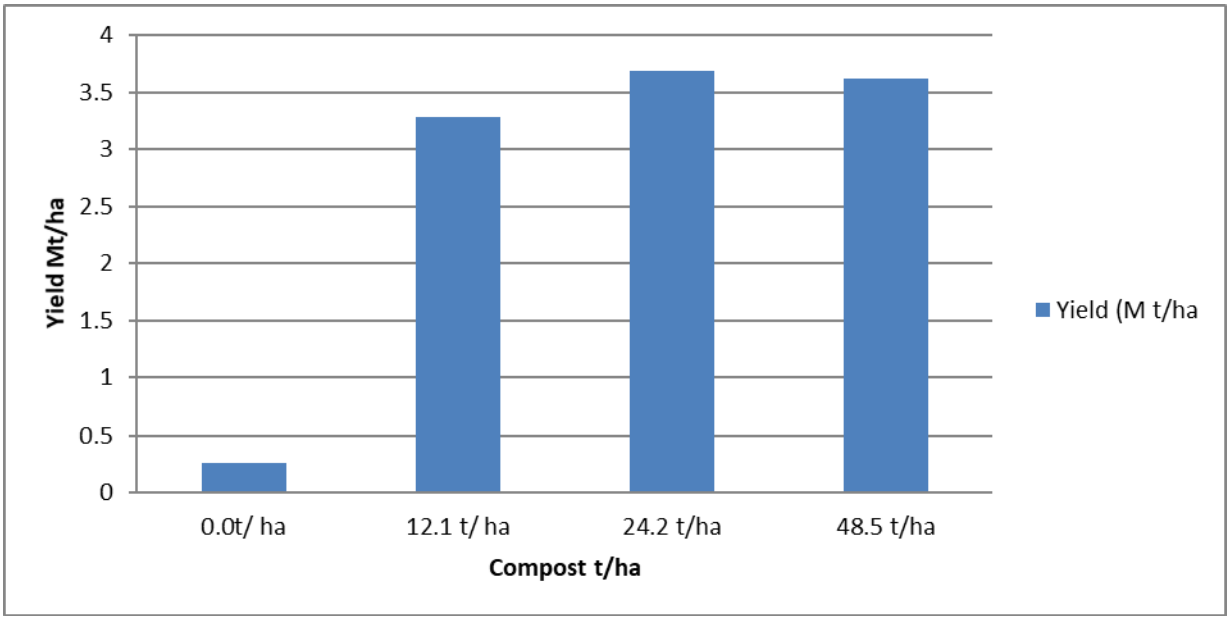

Figure 6. Yield results from the wet season trial (Mohammad *et al*., 2004).

Moreover, compost increases available form of nutrients for plant in soil and then increases root growth and nutrient uptake by plant that results in plant stem height and dry weight rise up (Soheil *et al*., 2012). Gamal (2009) also reported that application of 5 ton ha^{-1} compost increased sorghum grain yield by 45% as compared to no compost plots, while the grain yield was higher at composted plots (10 ton ha^{-1}) by 19% than no compost plots in different sites.

Compost use does not only improve the growth and productivity of crops in terms of quantity but it could be also proved that quality of agricultural products is influenced in a positive way (Mehammed *et al*., 2012). Gemal (2009) observed that the quality of corn crop was improved as the result of increasing compost application rate. Tayebeh *et al*. (2010) was also observed that compost had a significant effect on yield of wheat and the maximum amount of yield and yield component of wheat was obtained by 60 Mg compost ha^{-1} treatment.

Table 3. Effect of compost on wheat yield and yield components

Compost ($Mg\ ha^{-1}$)	Grain yield ($kg\ ha^{-1}$)	Spike number/ m^2	Seed number/ spikes	1000 grain Weight (g)
0	3025.80^{b}	479.20^{b}	15.21^{b}	39.42^{b}
30	5110.60^{a}	735.60^{a}	17.90^{ab}	38.69^{c}
60	5360.90^{a}	841.30^{a}	19.96^{a}	40.23^{a}

Means in the same column followed by the same letters are not significantly different ($P<0.05$), according to Duncan's test (Tayebeh *et al*., 2010).

On the contrary, organic manures like compost discharge nutrients very slowly to the plants and these nutrients are not directly absorb by the plants. Therefore, plants are unable access required amount of nutrients in the critical yield-forming period. Hence, an integrated approach, combining application of compost with an application of inorganic fertilizer is a good strategy for increasing crop productivity. Such combination also contributed to the improvement of physical, chemical and biological properties of soil. Assefa *et al*. (2016) conclude that the use of full dose of nationally blanket recommended NP rate (64/48 kg of N/ P_2O_5) with 7.5 tons ha^{-1} of compost is likely combination to attain the optimum grain yield and profit and can be alternative approach for integrated soil fertility management measure instead of the sole application of inorganic fertilizers.

Similarly, application of half the recommended N and P rate and half the recommended rate of manure and compost as inorganic N equivalence resulted in yield advantages of about 129% compared to the control (Agegnehu *et al*., 2014). Tayebeh *et al*. (2010) were also tested the effect of organic and inorganic fertilizers on grain yield and protein banding pattern of wheat, and he strongly suggested using combination of organic and inorganic fertilizer to achieve highest yield without negative effect on seed quality. Other author Habtamu, (2015) concludes that incorporating compost with inorganic fertilizers for maize improves plant nutrients for small-scale farmers of the Antra catchment, Northwestern Ethiopia.

Conclusions

With increasing fertilizer prices and limited resources reserves, organic amendments like compost and manure as a source of nutrients and organic matter are considered an economic and environmentally-friendly alternative. Compared to plant residue and manure, composts release nutrients more slowly and have longer- lasting effects.

The slow decomposition is more effective increasing soil organic matter content of the soil, which plays a key role in soil fertility by retaining nutrients, maintaining soil structure and holding water. They also have other advantages such as disposal and recycling of municipals solid wastes there by reducing material going into landfill.

The general effects of compost application on soil properties have been well recognized such as reducing bulk density, increasing soil structural stability, improving water holding capacity and plant water availability, decreasing leaching of nutrients, reducing erosion and evaporation in addition to enhancement of crop productivity. However, the effect of composts on soils is likely to be strongly dependent on compost composition, which depends on feedstocks, composting conditions and duration. In addition, some studies have indicated that the effects of compost application on soil and plant nutrients may be modulated by soil type.

Recommendations

- To make more effective organic residue for better agricultural production it should be decomposed to become stable humic substances (below 30:1 C: N).
- More research on nutrient cycling methods (composting) of different feed stocks especially urban solid waste and wastes generated by agro-industries are needed.
- Farmers should use integrated nutrient (both organic and in organic) rather using sole chemical fertilizer to enhance crop productivity.

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