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MUNICIPAL SOLID WASTE COMPOST APPLICATION AFFECTS SOIL PROPERTIES AND PRODUCTION OF POTATO

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Abstract

A field experiment utilizing potatoes received five treatments of MSW compost prior to sowing at control (without compost), compost at the rate of 2 tonnes acre^{-1}, compost at the rate of 3 tonnes acre^{-1}, compost at the rate of 4 tonnes acre^{-1}, compost at the rate of 5 tonnes acre^{-1}. Effects of these applications on the organic matter, pH and production of potatoes were measured. In comparison with control MSW compost increased the organic matter 0.71 and 0.84% at the application rate of 4 and 5 tonnes acre^{-1} respectively. Similarly in comparison with control compost addition increased the pH by 7.37 and 7.44 at application rate of 4 and 5 tonnes acre^{-1}, respectively. In comparison with control MSW compost addition increased the production by 6040 kg acre^{-1} to 9137 kg acre^{-1}.

Key words: Organic matter, MSW compost, potato, soil pH, production

INTRODUCTION

Organic matter is the most important component of the soil which acts as a therapy for improving the soil health. There is a difference between organic material and organic matter. Organic material is anything that was alive and is now in or on the soil. For it to become organic matter, it must be decomposed into humus (Funderburg, 2001). Thus, organic matter is stable in the soil and it has been decomposed until it is resistant to further decomposition. Usually, only about 5% of it mineralizes yearly. That rate of decomposition increases if temperature, oxygen and moisture conditions become favorable for decomposition, which often occurs with excessive tillage (Plaster, 1996).

Organic matter significantly affects the soil which leads to a complex chain of multiple benefits. In addition to supplying plant nutrients, the type and amount of soil organic matter influences several soil properties, particularly those related to physical conditions (Van-Camp et al., 2004; Clapp et al., 2005). It improves the soil structure, porosity, and density, thus creating a better plant root environment, increases moisture infiltration and permeability of heavy soils, which reduce erosion and runoff, improves water-holding capacity, thus reducing water loss and leaching in sandy soils, supplies a variety of macro and micronutrients, suppress certain soil-borne plant pathogens, improves cation exchange capacity of soils and growing media, improve media's ability to hold nutrients for plant use. Furthermore, it also supplies beneficial micro-organisms to

soils to growing media, improves and stabilizes soil pH and binds and degrades specific pollutants. Likewise, adding organic mulch to soil surface encourages earthworm activity leading to formation of burrows and other bio-pores, which in turn increases infiltration of water and decreases its loss as run-off (Siddiqui et al., 2007). The quantity and nature of the soil clay affects the amount of carbon stabilized in soil, since fine textured soils (clays) often contain higher amounts of OM than sandy soils (Mtambanengwe et al., 2004).

In recent years, composted urban waste has been added to agricultural land for both waste disposal and to improve soil fertility. Compost is rich in organic matter and an important source of nutrients for plants (Gallardo-Lara and Nogales, 1987) even though it may increase the level of potentially harmful trace metals and various persistent organic toxins (Giusquiani et al., 1995). Municipal solid wastes (MSW) are among the most abundant substrates that can be advantageously used for this purpose after being subjected to a suitable composting process that consists basically of a controlled, biological transformation of OM operated by aerobic microorganisms (Zucconi and De Bertoldi, 1987; De Bertoldi et al., 1996). Municipal solid waste is mixed waste from residential, commercial, institutional and industrial sources which includes paper, glass, wood, plastics, reusable goods, soils, chemicals, food waste, plant debris, metals, textiles, and rock and organic materials (50-70% of all municipal solid waste). Its decomposable potential is 60-90%. Ideally, the compost feedstock should only contain decomposable materials such as food scraps, paper, cardboard, yard waste, and wood (Mamo et al., 1998). Bottom ash is the most significant by-product of municipal solid waste (MSW) incineration. It accounts for 85-95% (w/w) of the solid products resulting from municipal solid waste combustion. It contains mostly mineral components like silicates and carbonates but also varying amounts of heavy metals (Chang et al., 2001; Thiepse and Dreizin, 2002).

Addition of two amendments, urban sewage sludge (USS) and municipal solid waste compost (MSWC) to soils provided an increase in their mineralization capacities; the highest carbon mineralization rate (Filipe et al., 2007). MSW compost is rich in organic matter and important source of nutrients in plants (Gullardo-Lara & Nogales, 1987). In many arable agricultural soils, soil microbial biomass is related to soil's organic matter content (Houot & Chaussad, 1995). Compost is a main source of organic matter (OM) and of nitrogen for organic farming in arid and semi-arid regions (Raviv et al., 2004). Municipal solid waste compost may be a good source of phosphorus for both potatoes and sweet corn (Mkhabela & Warman, 2005). Clark et al. (2000) amended a sandy soil with municipal solid waste compost, which significantly improved plant growth and yield in drip-irrigated vegetable production. Furthermore, all MSW compost treatments significantly increased soil pH compared to the inorganic fertilizer treatments. Similar results were reported by other investigators using MSW and other composts (Maynard, 1995; Copper and Warman, 1997; Khalilian et al., 2002)

One of characteristics in the soils of Punjab (Pakistan) is their low organic matter content, which greatly contributes to their limited fertility and production levels, and great exposure to contamination, degradation, erosion and desertification (Anonymous, 1996). Furthermore, decrease in soil organic matter content is paralleled by decline in soil fertility (Clapp et al., 1986). The decrease of SOM by erosion and leaching is considered one of the most important threats to soil (Blum et al., 2004; Van-Camp et al., 2004) and this loss can only be overcome, in the short-term, by the application of organic matter (Han et al., 2000; Dias, 2004; Parnaudeau et al., 2004). Currently, organic matter status of most of Pakistan's soils is only about 0.20%. For good crop production, soil should contain at least 1.2% organic matter, which is only in 4% soils of Pakistan (Anonymous, 1996). So, present research was conducted to elevate the soil organic matter by evaluating different dose rate of compost on potato crop. Potato crop was used as it shows good response to variation in soil organic matter contents (Clark et al., 2000).

MATERIALS AND METHOD

This research was carried out on potato in the premises of Lahore, Punjab (Pakistan). Urban waste compost and municipal solid waste was obtained from Lahore Compost Pvt. Ltd., which was applied to almost sandy soils, already low in organic matter content and slightly alkaline in pH. For experiment, 15 plots (each of one acre area) were selected. Cropping pattern of these plots was okra–pea/radish/carrot–bitter gourd–potato. Each treatment was replicated three times i.e. one plot for each replication. Treatments included T_0) control without compost, T_1) compost @ 2.0 tonnes acre^{-1}, T_2) compost @ 3.0 tonnes acre^{-1}, T_3) compost @ 4.0 tonnes acre^{-1} and T_4) compost @ 5.0 tonnes acre^{-1}. Before start of experiment, plots were analyzed for different important parameter including organic matter contents (Table 1). Application was carried out at the time of land preparation (September 2006). Final harvest of the crop was recorded along with soil pH and organic matter contents measurement (January 2007). Salient features of the applied compost are given in Table 1.

Table 1: Salient features of soil and compost used in experiment

	Soil	MSW Compost
Organic matter (%)	0.10 to 0.27	43.0
pH	7.26	7.48
C/N ratio	ND	11.25:1.0
Nitrogen (%)	0.02	2.30
Phosphorous (%)	ND	1.34
Potassium (%)	0.064	1.76

*ND (not determined)

RESULTS AND DISCUSSION

Higher organic matter contents were observed in soil treated with 5 tonnes acre^{-1} of MSW Compost followed by 4 tonnes acre^{-1} (Figure 1) as earlier revealed by Raviv et al. (2004) and Filipe et al. (2007).

The treatment with highest addition of organic matter was found to have maximum pH by 7.44 (Figure 2). By using MSW Compost, pH of soil can vary but soils of potato growing areas in Punjab are slightly alkaline and pH of compost used was 7.48. So when this compost was applied on already slightly alkaline soil then it caused minute addition towards alkalinity (Maynard, 1995; Cooper & Warman, 1997; Khalilian et al., 2002).

Similarly production of potatoes increased with increase in addition of compost. Higher potato yield (9.14 tonnes acre^{-1}) was obtained (Figure 3) with application of 5 tonnes acre^{-1} of MSW compost (T_4) followed by 8.86 tonnes acre^{-1} (T_3) as potato yield varies significantly with the variation in organic matter in soil (Clark et al., 2000).

It may be concluded that addition of compost to an agricultural soil positively affects organic matter

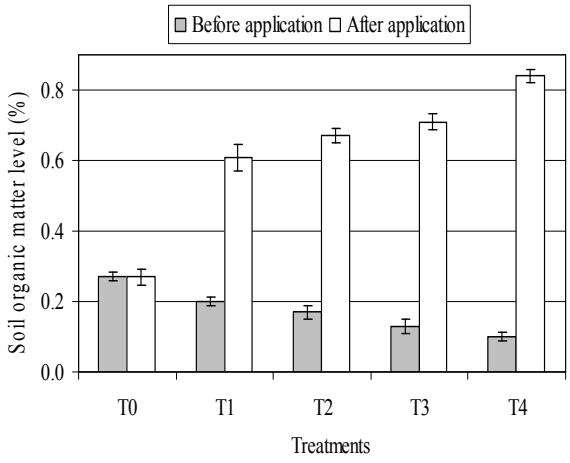

Figure 1: Organic matter in soil before and after Municipal Solid Waste (MSW) Compost application. Vertical bars represent mean (±S.E.) of three replications ($P \leq 0.05$)

contents and pH of soil. These two important soil properties respond to improve soil quality over relatively short time, consequently increase in crop yield.

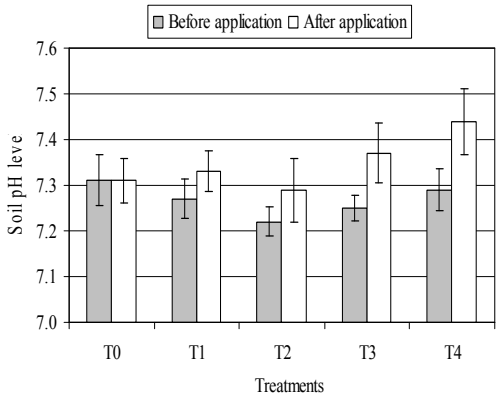

Figure 2: Soil pH level before and after Municipal Solid Waste (MSW) Compost application. Vertical bars represent mean (±S.E.) of three replications ($P \leq 0.05$)

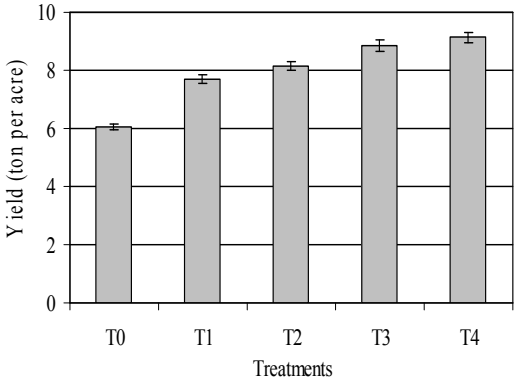

Figure 3: Effect of Municipal Solid Waste (MSW) Compost application on potato yield (tonnes acre^{-1}). Vertical bars represent mean (±S.E.) of three replications ($P \leq 0.05$)

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