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Original Article

Effect of municipal solid waste compost on yield and quality of eggplant

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Abstract

Organic agriculture aspires to return to more closed cycles of energy and materials, maximize re-use, employ rotation systems, use nutrients of organic origin and renewable energy sources, etc. Production of municipal solid waste compost, including organic waste is increasing while soils are progressively losing organic matter due to intensive cultivation and climatic conditions. This makes the recycling of organic waste as soil amendments a useful alternative to incineration, landfill or rubbish dumps. In this study that carry out in the summer of 2008, four levels of municipal solid waste compost (50, 100, 150 and 200 t. ha^{-1}) with control had applied. Through measured factors, marketable yield per m^2, number of weed per plot, soil born disease reduction, number of leaf per plant, lateral branch rate, plants height had significant effect in 0.05 levels. The best of yield achieved of 50 t. ha^{-1} fertilizer level. Municipal solid waste compost also had significant effect on Ca root, fruit, leaf and root P and leaf Mg.

Keyword: *Solanum melongena***,** compost, municipal solid waste, soil born disease, weed control

Efeito de composto de resíduos sólidos urbanos na produtividade e qualidade de berinjela

Resumo

A agricultura orgânica aspira a regressar a ciclos mais fechados de energia e materiais, maximizar os sistemas de re-uso, empregar sistemas de rotação, usar nutrientes de origem orgânica e fontes de energia renováveis, etc. A produção de compostos de resíduos sólidos urbanos, incluindo resíduos orgânicos está aumentando, enquanto os solos estão progressivamente perdendo matéria orgânica devido ao cultivo intensivo e às condições climáticas. Isso faz com que a reciclagem de resíduos orgânicos, como forma de promover alterações no solo, seja uma alternativa útil para a incineração, os aterros sanitários ou depósitos de lixo. Neste estudo, que foi realizado durante o Verão de 2008, quatro níveis de compostos de resíduos sólidos urbanos (50, 100, 150 e 200 t. ha^{-1}), com controle, foram aplicados. Os fatores analisados, produtividade comercial por m², número de plantas daninhas por parcela, redução de doenças originárias no solo, número de folhas por planta, taxa de ramos laterais e a altura de plantas tiveram efeitos significativos ao nível 0,05. O melhor rendimento alcançado sob o nível de 50 t.ha^{-1}. A compostagem de resíduos sólidos urbanos também teve efeito significativo sobre o Ca da raiz, frutas, folhas e do P das raízes e do Mg das folhas.

Palavras-chave: *Solanum melongena*, composto, resíduos sólidos urbanos, doenças de solo, controle de plantas daninhas

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Introduction

Eggplant (*Solanum melongena* L.) is an important crop in north and south provinces of Iran (Peyvast, 2008).

Research on organic farms, done over several decades, has revealed characteristics usually associated with sustainable farming, such as reduced soil erosion (Lockeretz et al.,1981), lower fossil fuel consumption (Lockeretz et al.,1981), less leaching of nitrate (Drinkwater et al., 1998), greater carbon sequestration (Drinkwater et al., 1998) and, of course, little to no pesticide use. Municipal solid waste (MSW) is largely made-up of kitchen and yard waste, and its composting has been adopted by many municipalities (Otten, 2001). Composting MSW is seen as a method of diverting organic waste materials from landfills while creating a product, at relatively low-cost, that is suitable for agricultural purposes. This trend may be attributed to economic and environmental factors (He et al., 1992; Otten, 2001; Hansen et al., 2006; Zhang et al., 2006).

Composting MSW reduces the volume of the waste, kills pathogens that may be present, decreases germination of weeds in agricultural fields, and destroys malodorous compounds (Jakobsen, 1995). The quality of MSW compost is dependent on many sources of variation including the composting facility design, feedstock source and proportions used, composting procedure, and length of maturation. A primary benefit of MSW compost is the high organic matter content and low bulk density (He et al., 1992; Soumare et al., 2003). A survey of MSW compost reported that on average, 20% of the total C in MSW compost was organic C, 8% carbonate C, and 71% residual C which may have included organic C components (He et al., 1992). Furthermore, the majority of the humic substances found in MSW compost were identified as humic acid, with a humic acid to fulvic acid ratio of 3.55 (He et al., 1992). Repeated application of MSW compost consistently increased soil organic matter content and soil C/N ratio to levels greater than those of unamended soil (Crecchio et al., 2004; Garcia-Gil et al., 2004; Montemurro et al., 2006). Municipal solid waste compost had a high water holding capacity because of its organic matter content, which in turn improved the water holding capacity of the soil (Hernando et al., 1989; Soumare et al., 2003).

Municipal solid waste compost has been reported to effectively supply P to soil with soil P concentration increasing (Iglesias-Jimenez, 1993; Zhang et al., 2006). A 10–50% of total P in MSW compost was available both the first and second year after application (Soumare et al., 2003).

At high MSW compost application rates (>200 Mg ha^{-1}), to supply adequate N, downward movement of P was observed (Zhang et al., 2006). Municipal solid waste compost has been reported to increase total and extractable soil Ca concentrations (Shanmugam & Warman, 2004; Warman et al., 2004; Zheljazkov & Warman,2004). Repeated applications for three consecutive years, progressively increased soil Ca concentrations compared to fertilizer treatments (Shanmugam, 2005). Increased soil Ca concentrations, however, did not result in increased plant uptake of Ca by blueberries (*Vaccinium sp.),* Swiss chard (*Beta vulgaris var. cicla*), and basil (*Ocimum basilicum* L.) (Warman et al., 2004; Zheljazkov & Warman,2004).

The main objective of this research was to study the effect of municipal solid waste compost on yield and quality of eggplant.

Material and Methods

The experiment was conducted from 29 March 2008 to 31 August 2008 on land at a experimental field located at Guilan province in North of Iran (altitude 7 meters below mean sea level, 37°16′N, 51°3′E). The eggplant seeds, local cultivar (Qalami), were sown on 29 March into greenhouse trays containing sand and peat (1:1 v/v).

The experiment was arranged in a randomized complete block with five treatments (0, 50, 100, 150 and 200 Mg ha^{-1}) and replicated three times with 10 plants in each replication. The data were subjected to ANOVA in SAS (ver. 9.1, SAS Institute, Inc.) where appropriate means were separated using the Least Significant Differences (LSD) test by using 0 Mg. ha^{-1} as a control.

After sowing seedlings were transferred to potting medium containing peat and cattle manure (1:1 v/v) and irrigated when it was necessary by top water. Seedlings were transplanted on 17 May, with a distance of 0.6 m × 0.6 m between rows and plants, respectively. Each plot area was 6 m^2 and total experiment field area was 100 m^2.

The soil was a sandy loam, pH 6.8; containing total N (3%), total C (1.5%), a C/N ratio of 0.5, 12, 68, 100 mg. kg^{-1} of Ca, P, and K, respectively; and with an EC of 0.08 ds. cm^{-1}. During bed preparation soil pH to a depth of 20 cm was measured in a 1:2.5 (v/v) soil–H2O suspension with a 716 DMS Titrino pH meter (Metrohm Ltd., Herisau, Switzerland) fitted with a glass electrode (Thomas, 1996). Compost purchase from bazyafte zobaleh co.® Rasht (Capital of Guilan province), Iran and analyzed before using in field (Table 1). Total soil and compost C was determined by oxidation with potassium dichromate and titration of excess dichromate with ammonium ferrosulfate (Kalembasa & Jenkinson, 1973). Soil and compost electrolytic conductivity (EC) was determined in a saturated solution extract of the soil (Rhoades et al., 1989). The mineral N concentrations (NH_4-N and NO_3-N) in soil and compost were determined in a Kjeldhal digestion. The soil was prepared by plowing and disking. Granular fertilizer, 150N-100P-300K kg. ha^{-1} was applied broadcast to field before transplanting according to results based on soil tests and worked into the soil. Irrigation was

Table 1. Municipal solid waste (MSW) measured characteristics.

Characteristic	MSW value	Characteristic	MSW value
pH	7.1	C/N (%)	13.0
EC (ds m^{-1})	5.8	P (mg kg^{-1})	10.4
Total Porosity (% by vol.)	59.5	K (mg kg^{-1})	7.1
Total N (%)	2.3	Ca (mg kg^{-1})	49.4
Total C (%)	29.8	Mg (mg kg^{-1})	3.1

effectuated with sprinklers for all plots delivering water at 1 L. min^{-1}. Irrigation was done twice a day for 20 min each time beginning immediately after transplanting. Fruits were harvested manually from 16 July to 31 August. Total yield was calculated on a hectare basis. Chopped fruit tissues were placed in a forced air drying oven at 75°C for 48 h for dry matter determination.

The following characteristics were recorded: marketable yield rate per plant, weed rate per square meter, average leaf number per plant, soil born pathogen control, lateral branch mean rate per plant, average plant height per plot, element content of Ca in root, Mg in leaves and P in fruit, leaf and root.

Phosphorus, Calcium and magnesium in fruits, leaves and roots were measured by spectrometry (JENWAY 6105 U.V/V) (Elliot & Dempsey, 1991).

Results and Discussion

Variance analysis showed that compost relieve significant affected marketable yield rate per m^2, weed number per square meter, mean of leaf rate per plant, soilborn pathogen control, lateral branches mean rate per plant and height mean of plant.

Mean comparison showed that between control and other compost levels there are significant difference. Highest yield achieve from 150 $Mg.ha^{-1}$ treatments and lowest yield achieve from control treatment (Figure 1). Compost may increase yield by improve long term physical and chemical properties such as water holding capacity, cation exchange capacity, bulk density, and percentage organic matter and increase microbial rather than the value as a fertilizer (Gallardo-Lara & Nogales, 1987).

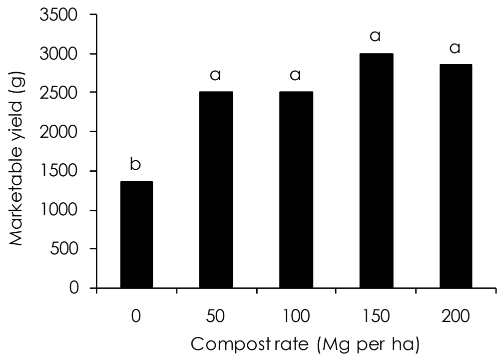

Figure 1. Effect of municipal solid waste (MSW) compost rate on marketable yield per m^2.

Mean comparison showed that there is significant difference between control and other compost rates and also there is no significant difference between 100 and 150 $Mg.ha^{-1}$ in weed control (Figure 2). Weed growth suppression is one of the most important effects of mulches (Food and Agriculture Organization, 1987). Weed suppression by mulches can be due to the physical pressure of the material on the soil surface, and action of phytotoxic compounds generated by microbes in the composting process (Ozores-Hampton et al., 1999). In general, germination of weed seed decline as burial depth increases and it has been attributed to several factor including light, temperate and moisture (Baskin & Baskin, 1989)

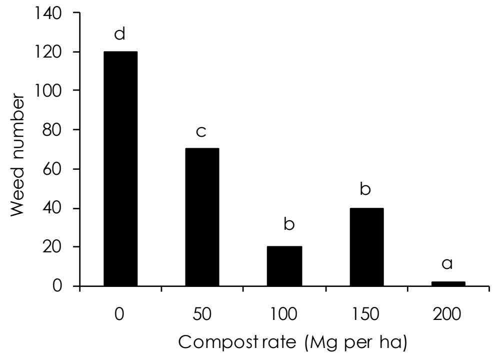

Figure 2. Effect of municipal solid waste (MSW) compost rate on weed number per square meter.

Mean comparison showed that there is significant difference between controls and other compost treatments and compost decrease plant number that infected by pathogens especially soilborn pathogens (Figure 3). Many types of microorganism present in compost amended container media function as biocontrol agents against disease caused by *Phytophthora* and *Pythium* spp. (Boehm et al., 1993). Propagules of these pathogens, if inadvertently introduced into compost-amended substrate do not germinate in response to nutrient released in the form of seed or root exudates (Chen et al., 1988). Propagules of these pathogens remain dormant and are typically not killed if introduced into compost-amended soil (Chen et al., 1988; Mandelbaum & Hadar, 1990).

Mean comparison showed that with increasing compost level, number of leaves increased and there is significant difference between treatments (Figure 4).

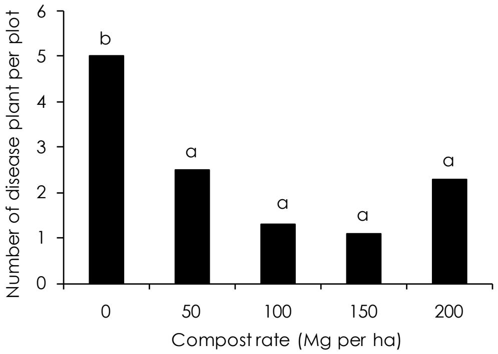

Figure 3. Effect of municipal solid waste (MSW) compost rate on soilborn disease control.

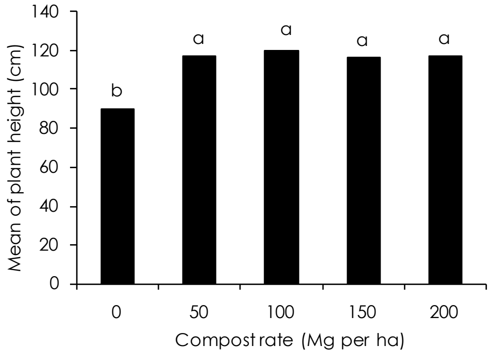

Figure 6. Effect of municipal solid waste (MSW) compost rate on average plant height.

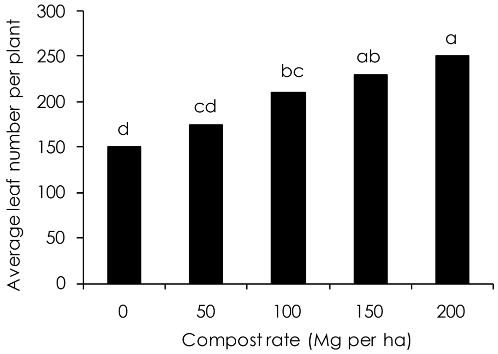

Figure 4. Effect of municipal solid waste (MSW) compost rate on average leaf number per plant.

In the present study compost had significant effect on average lateral branches number per plant. There is a significant difference between control, 50 and 100 $Mg.ha^{-1}$ compost treatments with 200 $Mg.ha^{-1}$ compost treatment. Lower number of lateral branch observed in the control and the highest number of lateral branch observed in 200 $Mg.ha^{-1}$treatment (Figure 5). Dasgan & Abak (2003) reported that number of leaves was increased by higher shoot numbers in two cultivars of pepper.

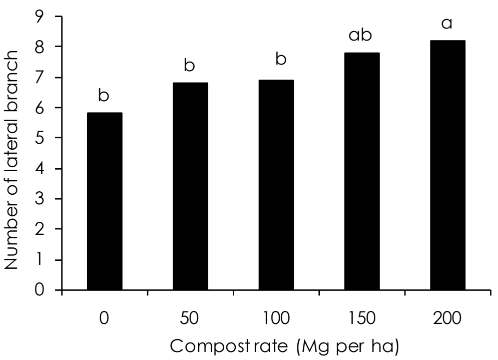

Figure 5. Effect of municipal solid waste (MSW) compost rate on lateral branches number per plant.

In the present study compost had significant effect on plant height and there is significant different between control and other treatment. Control had lower height and other treatment has no significant different together (Figure 6). It is important to register that increasing plant height redounds to enhancement number of node and fruit set in plants.

The Lowest Ca amount in roots was observed in 100 $Mg.ha^{-1}$ treatment and the highest level of Ca was obtained from 150 and 200 $Mg.ha^{-1}$ compost application (Figure 7). However after soil fertilization with MSW compost there are no significant differences between plants fruits and leaves Ca content. Ca is an immobile element and it accumulates in lower rate in fruit and leaf of plants. However, many researchers (Warman et al., 2004; Zheljazkov & Warman, 2004) reported that soil Ca increasing after compost application have no significant effect on plant Ca content.

Rate of P in root (Figure 8) and fruit (Figure 9) was higher for control treatment but only P rate in fruit is gradually reduced with increasing on compost rates. In relation to P leaf content, it was higher in 200 $Mg.ha^{-1}$ treatment and control had lowest content of P, i.e. the opposite registered for P rate in fruit. In study about P, Iglesias-Jimenez et al. (1993) reported that low mineralization rates of P were seen immediately after application, but after a residence time of 3 months, MSW compos provided sufficient P for plant growth. Giusquiani et al. (1988) and Iglesias-Jimenez et al. (1993) reported that soil P availability was increased with the addition of MSW compost, however, soil P retention decreased with increasing compost application because of competition between organic ligands and phosphate for sites on metallic oxides as well as the formation of phosphohumic complexes which can increase P mobility.

Mg leaf content depended on MSW compost rate, as can be seen in figure 11, detaching that the highest compost rate promoted the highest Mg leaf content, as also observed to P. This result was previously expected because, according to Table 1, the MSW used in the present experiment presented 3.1 mg kg^{-1} of Mg.

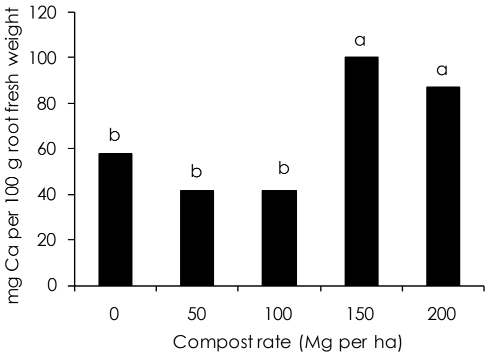

Figure 7. Effect of municipal solid waste (MSW) compost rate on root Ca content.

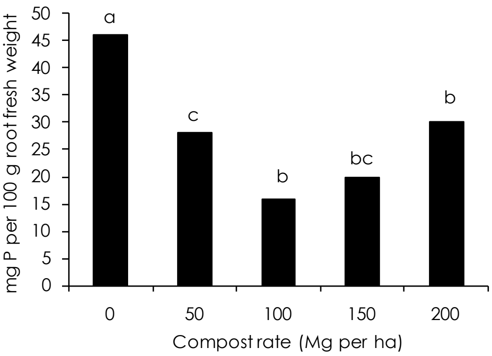

Figure 8. Effect of municipal solid waste (MSW) compost rate on root P content.

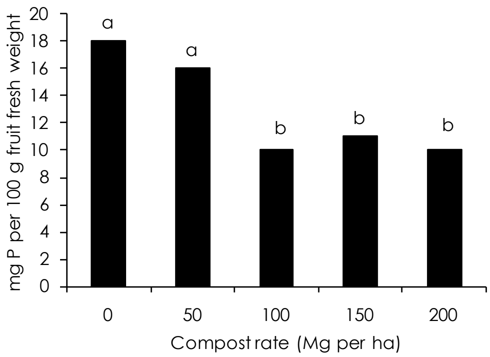

Figure 9. Effect of municipal solid waste (MSW) compost rate on fruit P content.

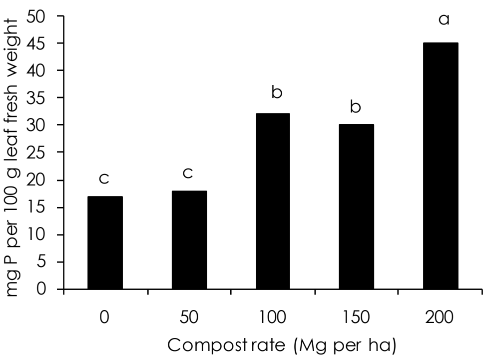

Figure 10. Effect of municipal solid waste (MSW) compost rate on leaf P content.

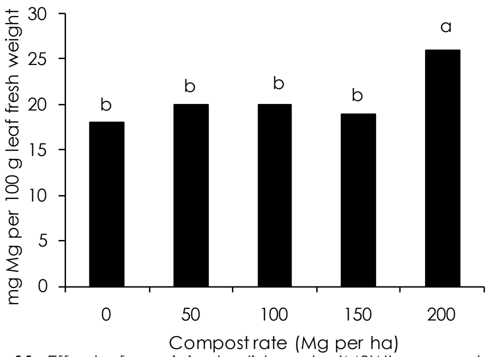

Figure 11. Effect of municipal solid waste (MSW) compost rate on leaf Mg content.

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