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Effect of municipal solid waste compost on weed control, yield and some quality indices of green pepper (*Capsicum annuum* L.)

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ABSTRACT

Application of Municipal Solid Waste Compost (MSWC) to soils could help to solve municipalities' problems. To investigate the effect of MSWC on weed control, yield parameters and some quality indices of green pepper, an experiment was conducted with 0, 100, 150 and 200 t. ha^{-1} MSWC in 2007 at the research station of the Guilan University, Rasht, Iran. Results showed that with increasing the MSWC to 150 t.ha^{-1}, plant length, branch and flower numbers, plant total fresh and dry weight, vitamin C content, chlorophyll a, b and total leaf chlorophyll of green pepper can increase significantly. Higher levels of MSWC (150 and 200 t. ha^{-1}) didn't showed any significant differences on the above mentioned characteristics. However, high an increasing of 150 up to 200 t. ha^{-1} MSWC could affect the yield, fruit and leaf numbers, fruits chlorophyll a, b and total chlorophyll content. Application of MSWC higher than 150 t. ha^{-1} could decrease significantly the numbers of several weeds such as *Amaranthus* spp., *Convulvulus* spp., *Bromus* spp., *Cinidon* spp. *Plantago* spp., and *Digitaria* spp. Further increasing of MSWC up to 200 t. ha^{-1} could not affect the number of *Bromus* spp., *Cinidon* spp., *Plantago* spp., and *Digitaria* spp. Our results showed also that fresh and dry weight, Zn and Cu content of pepper could increase with increasing of MSWC without any significantly differences.

Keywords: Municipal Solid Waste compost, *Capsicum annuum* L., yield, weed control, quality indices.

INTRODUCTION

Green peeper is one of the most important crops in north of Iran and consumed over year by meal due to high level of vitamin C and antioxidant. The acceptance of crop production can be influenced by the source of nutrients involved in its production. MSWC can be used as organic amendment in soils, providing them both organic matter and mineral nutrients, thus improving physical, chemical and biological properties of soil and increase crops yield (Garcia *et al.*, 1992; Pagliai *et al.,* 1981). Generally, in developed countries, a kilogram of vegetable produced using organic fertilizer attracts premium than the same quantity produced using synthetic fertilizer. This is because it is believed that the former is devoid of synthetic chemicals (Togun *et al.,* 2004). Generally, crop residues, manures, turfs, forest under story leaf falls, and compost from organic wastes have been used to increase soil organic mater content (Stratton *et al.,* 1995). Soil organic matter content has long been suggested as the single most important indicator of soil productivity (Haynes, 2005). These organic fertilizers could be produced from both municipal and agricultural wastes. Generation of organic waste is increasing worldwide and strategies for its environmental sound use must be developed and optimized (Togun *et al.,* 2004). Urbanization results in the production of huge amount MSW which needs safe disposal without damaging our environment. These waste materials can recycle significant amounts of plant nutrients especially nitrogen (N) thus reducing the cost of fertilizer

(Zaman *et al.,* 1999). In most cases, these organic materials cannot be used because of their disadvantages such as phytotoxicity, nitrogen immobilization, high salt content or structural incompatibility. Composting reduce many of these disadvantages (Verdonck, 1988). Composting is known to decrease C and to increase macro and microelements concentration in the final compost (Zheljazkov and Warman, 2003). Application of composts can contaminate vegetable and fruit by the heavy metals but this effect can be minimized by proper sorting and recycling of the material prior to composting (Kolota and Biesiada, 2000). MSWC can increase crop yield (Bazzoffi *et al.,* 1998; Mkhabela and warman, 2005; Peyvast and Abbassi, 2006), number of leaves (Peyvast and Abbassi, 2006), fresh and dry weight (Miyasaka *et al.,* 2001; Mkhabela and warman, 2005; Stabinkova *et al.,* 2005) plant length (Perez-Murica *et al.,* 2006) and chlorophyll content (Lima *et al.,* 2004).

Weeds in vegetable crop production systems that are high cost problem can be controlled by conventional practices such as hand hoeing, stale seed bed, solarization and mulching, mechanically such as cultivators, flame boring or chemically by herbicides (Stofella and Petterson, 2000). The benefits of mulching to improve growth and yield of annual and perennial crops have long been recognized (Shonbeck and Evanylo, 1998; Weber, 2003), where it often enhances growth and yield of crop. This enhancement has been attributed to the reduction of vegetable competition in the rooting zoon (Ricotta and Masiunas, 1991; Davis, 1994; Adams, 1997) and increase in availability of key soil sources such as nitrogen (clarkson, 1960; Wien *et al.,* 1993; Truax and Gognon, 1999) and water (Mcdonald and Helgerson, 1990; Truax and Gognon, 1999). Mulching has also been shown to accelerate early root growth and nutrient uptake (Waggoner *et al.,* 1960; Robinson, 1988; Mcdonald and Helgerson, 1990; Wien *et al.,* 1993). Mulched cover crops also may provide favorable microhabitats for beneficial insects (Orr *et al.,* 1997; Reader, 1991; Stinner and House, 1990), including entomophagous insects and weed seed predators (Pullar *et al.,* 2006). Immature MSWC as mulch (3.8-11.3 cm thick) effectively suppressed weeds in vegetable crop alleys up to 240 days (Ozores-Hampton *et al.,* 2005).

The main objective of this study was to study the effect of MSWC on the yield; quality and field weed control of green peeper when it will be used as mulch.

MATERIAL AND METHODS

The field study was carried out at the Agricultural Experiment Station of Guilan University, Rasht, Iran (altitude -7 m, 37°16'N, 51°3'E). Mean temperature and mean relative humidity during the experiment were 23.3°C and 77.1% respectively. The MSWC was produced under aerobic conditions at the Guilan Regional Recycling and composting Facility. Some chemical characteristics of soil and MSWC are shown in Table 1.

The experiment was laid out as a Randomized Complete Block Design (RCBD) with four MSWC treatment including T_0 (control), T_1 (100 t. ha^{-1} MSWC), T_2 (150 t. ha^{-1} MSWC) and T_3 (200 t.ha^{-1} MSWC), and three replications.

Table 1 : Selected physical and chemical properties of soil and MSWC

	pH[a]	Organic matter [b]	EC[c]	N [b]	P[d]	K[d]	Cu[d]	Zn[d]
Soil	7.5	0.65	0.7	0.22	62.1	259	2.4	6.2
Compost	7.1	50	4.9	2.56	158	15.5	3.1	7.3

[a] pH 1:1 dry matter: deionised water., [b] (%)., [c]dS m^{-1}., [d] mg Kg^{-1} dry matter.

200 Green pepper seeds Var. Shirin (local variety) were soaked on a layer of wet cotton stuff for 4 days at 25°C to allow seeds to sprout. Germinated seeds were individually covered with commercial peat in plastic trays and watered regularly. Once the plantlets reached a height of 20-25 cm, they were transplanted to the experimental plots. Plots sizes were 4.0 × 3.0 m with 4 rows of green pepper $plot^{-1}$. The plant distance was 60 × 50 cm (13333.3 plant ha^{-1}). The soil was covered with MSWC according to treatments after transplanting. Total fruit fresh and dry weight, total soluble solid, titrable acid, vitamin C content, chlorophyll a, b and total chlorophyll content of leaves and fruits, Zn and Cu content of fruit were analyzed. Weed number measured in plot until the canopy covered the field completely.

Fruits harvested weekly (45 days after planting). Dry matter was measured after drying plant material to constant weight in an oven at 70 °C. 100 mg of dried fruit were ashed in a muffle furnace at 450°C for 12 h. Ashes were digested in hot 2 N HCl for analysis of fruit Cu and Zn concentration. Chlorophyll extracted with N, N-Di methyl formamide and spectrum optical absorbance of solutions measured with spectrophotometer (Ulterospec 3000, Pharmacia Biotech Co.) (Inskeep and Bloom, 1985). Vitamin C content measured by titration with Dichloro phenol indol.

All statistical calculations and analysis of variance were conducted using Statistical Analysis System (SAS Institute, version 6/12).

RESULTS AND DISCUSSION

Results showed with increasing the MSWC soil Phosphorus increased significantly ($p<0.05$) (Table 2). Soil pH increased with additional compost without any significantly differences. This increase is probably due to the higher pH level of MSWC. Organic matter (OM), electrical conductivity (EC), nitrogen (N) and potash (K) contents could increase significantly when MSWC increased up to 150 t. ha^{-1}. Increasing of N in the soil is probably due to MSWC increase in the soil as organic matters, microbial community and activity to mineralize organic N sources. Mean concentrations of Cu and Zn in the soil were significantly higher ($p<0.05$) than the value in control. Higher contents of organic matter, electrical conductivity (EC), P, K, Cu and Zn in the soil could be probably due to the higher amount of MSWC supply. Our result is consistent with the soil quality hypothesis and with some earlier studies. Purves and Mackenzie (1972) reported that MSWC applied to soils in plot experiments with cabbages, lettuce, beans, potatoes and peas in three successive years had produced significant enhancement of available soil Cu and Zn in each year. Ozores-Hampton *et al.,* (2005) instated that, although higher levels of extractable Cu and Zn were observed from amended soils during 4 years, all were within acceptable levels.

The positive relationship of soil EC to compost application for the 0-20 cm depth shows an excessive content of salts in this compost. The rise in EC warns against continued application of

Table 2: Compraison of mean chemical properties of soil (0-20cm depth)

	pH^a	EC^b	Organic matter	N^c	P^d	K^d	Cu^d	Zn^d
T0	7.5^a	0.7^c	0.65^c	0.08^c	43.6^d	209.87^c	2.05^b	7.22^b
T1	7.3^a	1.3^b	1.51^b	0.28^b	53.4^c	236.05^b	2.12^a	7.25^a
T2	7.15^a	1.6^{ab}	1.68^a	0.33^a	59.06^b	248.3^a	2.15^a	7.26^a
T3	7.1^a	1.8^b	1.68^a	0.34^a	60.4^a	294.6^a	2.16^a	7.28^a

Mean with in rows followed by different letters are significantly different at $p<0.05$. Same letters within rows indicates no significant difference between means.

^{a}pH 1:1 dry matter: deionised water., ^{b}dSm^{-1}/, ^{c}(%)., ^{d}mg Kg^{-1}., high EC composts that may lead to salinization and result in N depletion, reduced nutrient cycling and impaired crop growth.

Result of this study proved that compost treatment, at high amount, significantly influenced the green pepper yield, stem length, leaves, branches, flowers and fruits number, total fresh and dry weight, vitamin C content, chlorophyll a, b and total chlorophyll content of leaf and fruit.

Total yield, leaf and fruit number of green pepper was highest when fertilized with compost and lowest when the compost was not supplied. The plants treated with the highest compost (200 $t.ha^{-1}$ MSWC) gave significantly highest yield (12420 $kg.ha^{-1}$) (Table 3). The lowest total yield (1900 $kg.ha^{-1}$) was obtained from plants without supplying of MSWC. The results indicated that yield increased when the compost amount increased. Our result was similar to the results of other researchers(Chu and Wong,1984; Miyasaka *et al.,* 2001; Togun *et al.,*2004; Lima *et al.,* 2004; Peyvast and Abbassi, 2006).

Table 3: Effect of MSW compost on yield and some quantity indices of Green pepper

	Total yield[a]	Plant leant	Leaf number	Branch number	Flower number	Fruit number	Fresh weight[b]	Dry weight[b]
T0	1900[d]	53.6[c]	156.03[d]	71.33[c]	221.3[c]	109.6[d]	148.97[c]	30.03[c]
T1	9975[c]	126.6[b]	492.01[c]	286[b]	800.1[b]	572[c]	488.63[b]	102.43[b]
T2	12040[b]	158[a]	731[b]	341.3[a]	919.7[a]	666.8[b]	650.47[a]	139.61[a]
T3	12420[a]	159.63[a]	793.67[a]	351.67[a]	946.69[a]	704.67[a]	688.8[a]	141.93[a]

Mean within rows followed by different letters are significantly different at $P<0.05$. Same letters within rows indicates no significant difference between means. [a]$Kg.ha^{-1}$, [b]gr.

It is also indicated that, with increasing of MSWC up to 150 $t.ha^{-1}$, plant length, numbers of branch and flower, total fresh and dry weight increase significantly (Table 3). Even lower rates of MSWC (6 to 120 $t.ha^{-1}$) than those applied in this experiment are reported to be typically used for tomato, carrot, taro, maize, pepper, watermelon and broccoli and increased plant length, leaf, branches and flower number, total fresh and dry weight per plant (Chu and Wong, 1984; Miyasaka *et al.,* 2001; Agassi *et al.,* 2004; Lima *et al.,* 2004; Togun *et al.,* 2004; Peyvast and Abbassi, 2006).

The effect of MSWC applications on the yield and development of green pepper might be due to the better macro and micro nutrient supplements and improved physical, chemical and biological properties of the growth medium in the treatment plots relative to the control.

Our results showed that, when compost increased up to 150 $t. ha^{-1}$, vitamin C, chlorophyll a, b and total chlorophyll content of leaf increase significantly (Table 4). However, no significantly differences were found between 150 and 200 $t. ha^{-1}$. The chlorophyll a, b and total chlorophyll content of fruit were received with application of 200 $t. ha^{-1}$ compost and showed significant different with other treatments (Table 4).

Chlorophyll and ascorbic acid synthesis increased with nitrogen content increased in the soil (Smirnof, 2000; Pankovic *et al.,* 2000; Zhao *et al.,* 2005). We have found the same results as the MSWC application was increased in the soil which increased the nitrogen content and affected positively the amount of chlorophyll and ascorbic acid. Lower rates of MSWC (30 $t.ha^{-1}$) than applied in this experiment are reported to be typically used for corn chlorophyll content increasing (Lima *et al.,* 2004).

Table 4: Effect of MSW compost on leaf and fruit content (mg. Kg^{-1})

	Vitamin C[a]	Leaf total Chlorophyll content[b]	Leaf Chlorophyll b content[b]	Leaf Chlorophyll a content[b]	Fruit total Chlorophyll content[b]	Fruit Chlorophyll b content[b]	Fruit Chlorophyll a content[b]
T0	83.01[c]	38.38[c]	13.71[c]	25.28[c]	3.87[d]	0.28[d]	3.62[d]
T1	153.3[b]	59[b]	31.4[b]	28.26[b]	14.36[c]	3.36[c]	11.09[c]
T2	191.68[a]	74.27[a]	44.22[a]	31.42[a]	22.13[b]	4.61[b]	17.7[b]
T3	203.66[a]	74.57[a]	44.25[a]	31.47[a]	22.69[a]	4.87[a]	18.01[a]

Mean within rows followed by different letters are significantly different at P<0.05. Same letters within rows indicates no significant difference between means. [a]mg. 100g fresh matter^{-1} and [b]mg. Kg^{-1}

Cu and Zn content of fruit increase with MSWC application but no significant differences ($p<0.05$) were found in the mean concentration of them (Table 5). Our result were not similar to Purves and Mackenzie (1972), Zheljakov and Warman (2003), Warman and Termeer (2005). Purves and Mackenzie (1972) reported that MSWC applied to soils significantly increased in uptake were as follows: Cu and Zn With lettuce and beans, Zn with potatoes. No significant increases in uptake of any of these elements were obtained in two experiments with cabbages. Zheljakov and Warman (2003) stated that, the addition of compost to the soil resulted in an increase of all Cu (exchangeable (EXCH-Cu), iron and manganese oxides (FeMnOX), organic mater (OM) and HNO_3 fractions) and Zn (carbonate (CARB), FeMnOX, OM and HNO_3 fractions) fractions relative to the control. Warman and Termeer (2005) were noted that using long term of Septic Waste and Sludge compost produced the highest forage Zn and Cu. It seems that uptake and accumulation of heavy metals such as Cu and Zn are related to kind of compost, using time, compost application form (mulching or mixture with soil) and plant type.

Tabel 5: Effect of MSW compost on fruit Vitamin C, Cu and Zn content (mg. kg^{-1})

	Fruit Cu content[a]	Fruit Zn content[a]
T0	0.18[a]	0.10[a]
T1	0.19[a]	0.11[a]
T2	0.19[a]	0.11[a]
T3	0.21[a]	0.11[a]

Mean within rows followed by different letters are significantly different at P<0.05. Same letters within rows indicates no significant difference between means.[a]mg Kg^{-1}

Table 6: Effect of MSW compost on weed numbers

	***Amaranthus* spp.**	***Bromus* spp.**	***Concolvulus* spp.**	***Cindon* spp.**	***Digitaria* spp.**	***Plantago* spp.**
T0	23.33[a]	167.66[a]	26[a]	27.66[a]	10[a]	14.66[a]
T1	5.33[b]	65.33[b]	5.66[b]	18[b]	3[b]	4.66[b]
T2	0[b]	23[c]	0[b]	2[b]	0[b]	0[b]
T3	0[b]	3[c]	0[b]	0[b]	0[b]	0[b]

Mean within rows followed by different letters are significantly different at P<0.05. Same letters within rows indicates no significant difference between means.

All MSWC treatments reduced significantly weeds density in comparison to the control treatment (Table 6) except of *Bromus spp.* Other weeds can not emergence in T_3 (10 cm or 200 $t.ha^{-1}$ MSWC). With increasing the MSWC up to 150 $t.ha^{-1}$, number of *Bromus spp., Cinidon spp. Plantago spp.,* and *Digitaria spp.* decreased significantly. However, no significant differences were found between 150 and 200 $t.ha^{-1}$ of MSWC. Numbers of *Amaranthus spp.* and *Convulvulus spp.* were decreased with application of 100 $t.ha^{-1}$ MSWC without any significantly differences between treatments. Weed suppression attributed to organic mulches (Grantzau, 1987; Singh *et al.,* 1985) or composts (Roe, 1993) has been reported. Reduced weed germination, emergence or seedling growth under compost mulches may result from-the physical presence of the material or phytotoxic substances produced during the continuing decomposition process (Stoffela and Patterson, 2000).

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