African Journal of Biotechnology Vol. 8 (19), pp. 4953-4957, 5 October, 2009
Available online at http://www.academicjournals.org/AJB
ISSN 1684–5315 © 2009 Academic Journals

Full Length Research Paper

The effect of sheep-manure vermicompost on quantitative and qualitative properties of cucumber (*Cucumis sativus* L.) grown in the greenhouse

Rasool Azarmi*, Mousa Torabi Giglou and Behzad Hajieghrari

Department of plant productions, Moghan Jounior College of Agriculture, University of Mohaghegh Ardabili, Ardabil, Iran.

Accepted 26 May, 2009

This experiment aims to evaluate the effects of vermicompost produced from sheep manure on growth, yield and quality of 2 fruit cucumber (*Cucumis sativus* L.) varieties (cv. 'Sultan F1' and cv. 'Storm F1') under greenhouse condition. Four vermicompost treatments at the rate of 0 (control), 10, 20 and 30 t ha^{-1} were incorporated into the top 15 cm of soil. During the experiment, fruits were harvested three times per week and fruit number and weight were recorded for 3 months. Leaf number, plant height and chlorophyll content were measured at 30, 60 and 90 days after transplanting, while leaf area, stem and leaf dry weight and fruit qualitative properties were evaluated at 90 days after transplanting. The results showed that leaf number, plant height and chlorophyll content increased significantly ($P \leq 0.05$) compared to control plots for both varieties at 30, 60 and 90 days after transplanting. The plots treated with 30 t ha^{-1} vermicompost showed increase in leaf are, stem and leaf dry weight for both varieties. The application of vermicompost at 30 t ha^{-1} increased total fruit yield 26% for cv. 'Sultan F1' and 25% for cv. 'Storm F1' compared to the control. The plots treated with vermicompost at 30 t ha^{-1} enhanced fruit number per plant 26% for cv. 'Sultan F1' and 25% for cv. 'Storm F1' than plot without vermicompost. Fruit harvested from plants receiving vermicompost had higher total soluble solid (TSS), lower juice acidity and more dry matter than plots without vermicompost. Growth and yield parameters were improved with increasing vermicompost rates up to 20 t ha^{-1}. There are no significant different between plots at 20 and 30 t ha^{-1} vermicompost in all evaluated parameters.

Key words: Vermicompost, quantitative, qualitative, greenhouse cucumber.

INTRODUCTION

Vermicomposts are finely-divided, peat-like material, with high porosity, aeration, drainage, water holding capacity and microbial activity which make them excellent as soil conditioner and as plant growth media (Edwards and Burrows, 1988; Edwards, 1998; Atiyeh et al., 2001). Several experiments have demonstrated that vermicompost contain plant- growth regulating materials such as humic acid (Senesi et al., 1992; Masciandaro et al., 1997) and plant growth hormones like auxins, gibberellins and cytokinins (Krishnamoorthy and Vajranabhiah, 1986; Tomati et al., 1990), which are probably responsible for increased germination, growth and yield of plants, in response to vermicompost applications (Atiyeh et al., 2002). The use of organic amendments such as traditional thermophilic composts has been used to increase crop productivity and yields (Bwamiki et al., 1998; Johnston et al., 1995; Maynard, 1993) and their use has been associated with improved soil structure, enhanced soil fertility and increased soil microbial population as well as activity and an improved moisture holding capacity of the soil (Zink and Allen, 1998; Barakan et al., 1995). Organic amendments like vermicompost promote humification, increased microbial activity and enzyme production, and increase the aggregate stability of soil particles, resulting in better aeration (Perucci, 1990). Organic matter has a property of binding mineral particles like calcium, magnesium and potassium in the form of colloids of humus and clay, facilitating stable aggregate of soil particles for desired porosity to sustain plant growth (Tisdale and Oades,

*Corresponding author. E-mail: ras_5242@yahoo.com. Tel.: 098 9143520673. Fax: 0987463418.

Table 1. Chemical properties of sheep manure vermicompost and soil.

	pH	EC ($mScm^{-1}$)	C (%)	N (%)	P (%)	K (%)	Fe (ppm)	Mn (ppm)	Zn (ppm)	Cu (ppm)
Vermicompost	7.7	7	15	1.3	1.3	1	580	250	170	31
Soil	7.66	1.38	1.01	0.09	0.001	0.039	14	11	5	1.1

1982). Despite the beneficial effects of compost in improving soil fertility and other soil characteristics, high metal concentrations in this material may limit its utilization. Furthermore, the application of high amount of vermicompost from composted urban wastes might cause significant reduction in the soil fungi activity, which must be taken into account when using these organic amendments in agricultural systems (Sainz et al., 1998). The application of a range of humic acids, that had been extracted from vermicomposts and then added to MM 360, with all needed nutrients, increased the overall growth of tomatoes and cucumbers significantly in a very similar pattern to the effects of a range of vermicomposts (Arancon et al., 2006; Arancon et al., 2008). However plant growth hormones can become adsorbed into the complex structure of humic acids that are produced very rapidly in vermicomposts (Canellas et al., 2000) and may have acted in conjunction with them to influence plant growth, since humates have also been shown to increase plant growth.

The main aims of this study were to assess the effect of different rates of vermicompost on growth, yield and quality of 2 cucumber varieties under greenhouse condition.

MATERIALS AND METHODS

The experiments were conducted, at Moghan Jounior College of Agriculture, Iran, during 2008. Sheep manure was composted thermodynamically for 3 months with mechanical turn cycles every 10 days. For preparing vermicompost, 400 mature worms (*Eugenia fetida*) were added to each m^2. The worms were removed with a pile of fresh materials that placed inside of the vermicomposted sheep manure which recalled them by attraction of the fresh feed. In this experiment, cucumber seedlings were planted in the plotted greenhouse in which each experimental plot had 3 m long and 3 m wide and each plot was separated by 1 m width from each other. The vermicompost and greenhouse soil chemical analyses are summarized in Table 1. Before transplanting, vermicompost was applied at the rate of 0 (control), 10, 20 and 30 t ha^{-1} and incurporated into the top 15 cm of soil in the whole experimental plots. The plots were arranged in a randomized complete block design with 4 replications. Cucumber seeds (*Cucumis sativus* var. 'Sultan F1' and 'Storm F1') were sown into cell plug trays filled with peat moss and there was one seed per cell. After sowing, the plug trays were placed in a greenhouse until emergence. Cucumber seedlings were transplanted in the plotted greenhouse, 35 days after sowing and when they had 3 true leaves. Seedlings were spaced at 90 × 40 cm and a plant density of 2.7 plants per m^2. All treatments were watered with drip irrigation system using tap water and 20:10:20 (N: P: K) fertilizer was applied once per week.

The plant height, leaf numbers and chlorophyll content were measured 30, 60 and 90 days after transplanting. Plant height (from soil level to the top node) and total leaf number (except cotyledon) of each plant were recorded. Average plant heights and leaf numbers per treatment were calculated. In this experiment, a commercial nondestructive dual-wavelength meter (Model SPAD-502, Minolta Crop) was used to directly estimate chlorophyll content. At the end of growth period, 4 plants from each treatment were harvested to measure leaf area, stem and leaf dry weight. Cucumber stems and leaves were separately placed in paper bags and dried at 60°C in the oven in order to measure dry weight. For measuring leaf area, all leaves were collected and passed through an LI-COR (LI-3100) leaf area measuring machine. To determine fruit yield, cucumber fruits were harvested at ripening stage 3 times a week for 3 months to record fruit number and to measure fruit weight. For evaluating the quality parameters, cucumber fruits were harvested at the ripening stage and total soluble solids were determined by convex refract meter (Medline-England) corrected for temperature 25°C. The pH and EC were measured by pH meter (CD 510, WPA) and EC meter (Sension 7, HACH). 3 fruits with the same color and size from samples were selected and oven-dried at 100°C to measure fruit dry matter content.

Data obtained from this experiment were subjected to analysis of variance using SAS (SAS, 2002 Institute Inc., Cary, NC, USA) software. One-way ANOVA with a general linear model (GLM) was used and least significant difference (LSD; P = 0.05) values were used to compare treatment means.

RESULTS AND DISCUSSION

Plant growth and yield parameters

Leaf number, plant height and chlorophyll content were significantly ($P \leq 0.05$) affected by vermicompost treatments for both varieties at 30, 60 and 90 days after transplanting. Plots with 20 and 30 t ha^{-1} vermicompost had greater leaf numbers than plot without vermicompost at 30, 60 and 90 days after transplanting for both varieties (Table 2). Application of vermicompost increased stem heights in response to different rates of vermicompost for both varieties at 30, 60 and 90 days after transplanting (Table 3). 30 days after transplanting, the highest chlorophyll content was obtained at 20 and 30 t ha^{-1} vermicompost, while at 60 and 90 days after transplanting the maximum chlorophyll content was obtained at 30 t ha^{-1} vermicompost for both varieties (Table 4). The results showed that application of vermicompost had significantly ($P \leq 0.05$) effect on leaf area. The plots treated with vermicompost at 30 t ha^{-1} increased leaf area 18% for cv. 'Sultan F1' and 22% for cv. 'Storm F1' compared to the control (Table 5). At 20 and 30 t ha^{-1} of vermicompost, the plants had significantly ($P \leq 0.05$) greater stem and leaf dry weight than the control. Vermicompost application at 30 t ha^{-1} enhanced stem dry weight 33% for cv.

Table 2. Effect of vermicompost rate on number of leaves at 30, 60 and 90 days after transplanting cucumber cv. 'Sultan F1' cv. 'Storm F1'.

Vermicompost ($t\ ha^{-1}$)	Sultan			Storm		
	30 days	60 days	90 days	30 days	60 days	90 days
0	9.38c	23.50c	35.83c	10.83c	26.67c	45.33b
10	10.50bc	25.17b	37.17c	12.00bc	29.00b	47.17ab
20	11.50ab	28.00a	39.33b	12.67ab	30.00ab	48.17a
30	12.00a	29.50a	41.17a	13.83a	31.83a	49.33a

Means followed by the same letters in each column do not significantly differ ($P \leq 0.05$).

Table 3. Effect of vermicompost rate on stem height at 30, 60 and 90 days after transplanting cucumber cv. 'Sultan F1' cv. 'Storm F1'.

Vermicompost ($t\ ha^{-1}$)	Sultan			Storm		
	30 days	60 days	90 days	30 days	60 days	90 days
0	40.33c	124.00c	196.2b	45.50c	147.00b	251.20c
10	53.17bc	134.80b	209.8ab	61.17b	163.80ab	269.20b
20	57.50ab	145.70a	225.8a	68.17ab	175.20a	275.80ab
30	69.67a	148.00a	239.7a	78.00a	177.7a	287.00a

Means followed by the same letters in each column do not significantly differ ($P \leq 0.05$).

Table 4. Effect of vermicompost rate on chlorophyll content at 30, 60 and 90 days after transplanting cucumber cv. 'Sultan F1' cv. 'Storm F1'.

Vermicompost ($t\ ha^{-1}$)	Sultan			Storm		
	30 days	60 days	90 days	30 days	60 days	90 days
0	37.37b	40.33c	43.60d	35.87c	39.93d	44.90d
10	39.07b	41.87bc	45.23c	36.37bc	42.03c	47.35c
20	40.73ab	42.47b	46.90b	38.30ab	43.20b	49.40b
30	43.93a	44.40a	48.73a	39.00a	44.56a	50.80a

Means followed by the same letters in each column do not significantly differ ($P \leq 0.05$).

Table 5. Effect of vermicompost rate on leaf area, stem and leaf dry weight of cucumber *cv.* 'Sultan F1' *cv.* 'Storm F1'.

vermicompost ($t\ ha^{-1}$)	Leaf area (cm^2)		Stem dry weight ($g\ plant^{-1}$)		leaf dry weight ($g\ plant^{-1}$)	
	Sultan	Storm	Sultan	Storm	Sultan	Storm
0	7100c	7705c	23.31c	27.25b	50.67c	54.13c
10	7712b	8404b	27.17b	30.25b	55.76b	61.05b
20	8060ab	9075a	28.57ab	34.15a	61.85a	66.40a
30	8350a	9390a	30.99a	36.03a	65.76a	67.55a

Means followed by the same letters in each column do not significantly differ ($P \leq 0.05$).

'Sultan F1' and 32% for cv. 'Storm F1' compared to the control. The plots treated whit vermicompost at 30 $t\ ha^{-1}$ increased leaf dry weight 30% for cv. Sultan F1' and 32% cv. 'Storm F1' compared with the control plot (Table 5).

The application of vermicompost increased significantly ($P \leq 0.05$) number of fruits and total fruit yield per plant in compared to the control. The plots treated with vermincompost at 30 $t\ ha^{-1}$ enhanced total fruit yield 26% for cv. 'Sultan F1' and 25% for cv. 'Storm F1' than plot without vermicompost.

The effect of vermicompost on cucumber plant growth could be attributed to presence of plant growth regulators and humic acid in vermicompost, which are produced by increased activity of microbes such as fungi, bacteria,

Table 6. Effect of vermicompost rate on yield parameters of cucumber cv. 'Sultan F1' cv. 'Storm F1'.

vermicompost ($t\ ha^{-1}$)	No. of fruit per plant		Total yield ($g\ plant^{-1}$)	
	Sultan	Storm	Sultan	Storm
0	29.67c	31.67c	2817c	2967c
10	33.00b	34.00bc	3067b	3275b
20	35.55a	37.00ab	3393a	3583ab
30	37.33a	39.67a	3537a	3703a

Means followed by the same letters in each column do not significantly differ ($P \leq 0.05$).

Table 7. Effect of vermicompost rate on quality properties of cucumber cv. 'Sultan F1' cv. 'Storm F1'.

vermicompost ($t\ ha^{-1}$)	pH of juice		TSS (%)	
	Sultan	Storm	Sultan	Storm
0	4.050c	4.230d	5.975a	6.020a
10	4.250b	4.435c	5.920a	5.900b
20	4.544a	4.585b	5.775b	5.800c
30	4.450a	4.680a	5.660b	5.750c

Means followed by the same letters in each column do not significantly differ ($P \leq 0.05$).

yeasts, actinomycetes and algae (Arancon et al., 2004). The microbes are also capable of producing auxins, cytokinins and gibberellins during vermicomposting (Brown, 1995; Arancon et al., 2004), which affects plant growth appreciably (Tomati et al., 1990; Arancon et al., 2004). Krishnamoorthy and Vajranabhiah (1986) demonstrated that earthworm activity could dramatically promote the production of cytokinins and auxins in organic waste. They also showed that there were strong positive correlations between earthworm populations and amount of cytokinins and auxins produced in field soils. Also they revealed that cytokinins and auxins produced by interactions between earthworms and microorganisms could persist in soil for up to 10 weeks but degraded rapidly if exposed to sunlight. Atiyeh et al. (2002) reported that plant hormones such as IAA, kinetin and gibberellins are relatively transient in soil because of their solubility and rapid breakdown in ultraviolet light. Mishra et al. (2005) demonstrated that vermicompost had beneficial effects on growth and yield of upland rice and significantly increased seed germination, chlorophyll concentration and yield. Arancon et al. (2004) reported positive effects of vermicompost on growth and yield of strawberry; especially increases in leaf area, shoot dry weight and fruit weight under field conditions. We previously reported the effect of vermicompost on the increased growth and yield of tomato as a result of an improvement in soil physical properties, soil fertility and uptake of mineral nutrient (Azarmi et al., 2008)

The effect of vermicompost on leaf number and height stem was same at 30, 60 and 90 days after transplanting. Plants in plots treated with vermicompost showed increase in growth parameters like leaf area, chlorophyll content, stem dry weight and leaf dry weight than with plots receiving inorganic fertilizer only. This indicates positive effects of vermicompost on growth of cucumber. With increasing rate of vermicompost from 0 to 20 $t\ ha^{-1}$, there was significant increase in growth; however above 20 $t\ ha^{-1}$ of vermicompost could not significantly increase growth. This different response of plant to rate of vermincompost might be due to differential rates of release of growth-promoting substance (Rajbir et al., 2008). The results indicated that 20 $t\ ha^{-1}$ vermicompost was adequate to supply the desirable amount of growth promoting substance for higher growth and yield of cucumber.

Fruit quality properties

The application of vermicompost to soil had no significant effects on cucumber juice EC (Table 8). Fruits harvested from plants that received vermicompost had significantly ($P \leq 0.05$) greater total soluble solid (TSS) and lower acidity than those harvested from the control plot for both varieties. The application of vermicompost at 30 $t\ ha^{-1}$ enhanced fruit TSS 9.8% for cv. 'Sultan F1' and 10.7% for cv. 'Storm F1' compared to the control plot (Table 6). The highest and lowest pH values were observed at 0 and 30 $t\ ha^{-1}$ respectively for both varieties (Table 7). Plants receiving 30 $t\ ha^{-1}$ vermicompost produced better

Table 8. Effect of vermicompost rate on quality properties of cucumber cv. 'Sultan F1' cv. 'Storm F1'.

Vermicompost ($t\ ha^{-1}$)	EC of juice ($mScm^1$)		Fruit dry matter (%)	
	Sultan	Storm	Sultan	Storm
0	4.860a	4.900a	5.43c	5.70c
10	4.850a	4.900a	5.65b	5.85b
20	4.795a	4.850a	5.80a	5.93a
30	4.755a	4.800a	5.81a	6.00a

Means followed by the same letters in each column do not significantly differ ($P \leq 0.05$).

quality fruits but there was no significant difference in fruit quality between 20 and 30 $t\ ha^{-1}$ vermicompost. The improvement of fruit quality may be attributed to better growth of plant at different rate of vermicompost, which might have favored the production of better colored and quality fruit (Rajbir et al., 2008).

ACKNOWLEDGEMENT

We would like to express our special thanks to the University of Mohaghegh Ardabilli for financial support of the research through a scientific research grant.

REFERENCES

Arancon NQ, Edwards CA, Bierman P (2006). Influences of vermicomposts on field strawberries: effects on soil microbial and chemical properties. Bioresour. Technol. 97: 831-840.

Arancon NQ, Edwards CA, Bierman P, Welch C, Metzer JD (2004). Influence of vermicomposts on field strawberries: effect on growth and yields. Bioresour. Technol. 93: 145-153.

Arancom NQ, Edwards CA, Babenko A, Cannon J, Galvis P, Metzger JD (2008). Influence of vermicomposts, produced by earthworms and microorganisms from cattle manure, food waste and paper waste, on the germination, growth and flowering of petunias in the greenhouse. Appl. Soil Ecol. 39: 91-99.

Atiyeh RM, Edwards CA, Subler S, Metzger J (2001). Pig manure as a component of a horticultural bedding plant medium: effect on physiochemical properties and plant growth. Bioresour. Technol. 78: 11- 20.

Atiyeh RM, Lee S, Edwards GA, Arancon NQ, Metzger JD (2002). The influence of humic acids derived from earthworms-processed organic wastes on plant growth. Bioresour. Technol. 84: 7-14.

Azarmi R, Sharifi Ziveh P, Satari MR (2008). Effect of vermicompost on growth, yield and nutrient status of tomato (*Lycopersicom esculentum*). Pak. J. Biol. Sci. 1(14): 1797-1802.

Barakan FN, Salem SH, Heggo AM, Bin-Shiha MH (1995). Activities of rhizosphere microorganisms as affected by application of organic amendments in a calcareous loamy soil 2. Nitrogen transformation. Arid Soil Res. Rehabilitation, 9(4): 467-480.

Brown GG, (1995). How do earthworms affect micro floral and faunal community diversity? Plant Soil, 170: 209-231.

Bwamiki DP, Zake JYK, Bekunda MA, Woomer PL, Bergstrom L, Kirchman H (1998). Use of coffee husks as an organic amendment to improve soil fertility in Ugandan banana production. Carbon nitrogen dynamics natural agric. trop. Ecosyst. 1998: 113-127.

Canellas LP, Olivares FL, Okorokova AL, Facanha AR (2000). Humic acids isolated from earthworm compost enhance root elongation, lateral root emergence, and plasma H^+-ATP ase activity in maize roots. Plant Physiol. 30: 1951-1957.

Edwards CA (1998). The use of earthworm in the breakdown and management of organic waste. In: Earthworm Ecology. ACA Press LLC, Boca Raton, FL, pp. 327-354.

Edwards CA, Burrows I (1988). The potential of earthworm compost as plant growth media. In: Edwards CA, Nauhauser A (Eds.), Earthworm in Environmental and waste Management. Springer, Netherlands, pp. 211-220.

Johnston AM, Janzen HH, Smith EG (1995). Long-term spring wheat response to summer fallow frequency and organic amendment in southern Alberta. Can. J. Plant Sci. 75(2): 347-354.

Krishnamoorthy RV, Vajranabhiah SN (1986). Biological activity of earthworm casts: an assessment of plant growth promoter levels in casts. Proceedings of the Indian Academy of Sciences. Anim. Sci. 95: 341-351.

Masciandaro G, Ceccanti B, Gracia C (1997). Soil agro-ecological management: fetigation and vermicompost treatments. Bioresour. Technol. 59: 199-206.

Maynard AA (1993). Evaluating the suitability of MSW compost as soil amendment in field-grown tomatoes. Copost Sci. Utilization, 1: 34-36.

Mishra MS, Rajani K, Sahu-Sanjat K, Padhy Rabindra N (2005). Effect of vermicomposted municipal solid wastes on growth, yield and heavy metal contents of rice (Oryza sativa). Fresenius Environ. Bull. 14: 584-590.

Perucci P (1990). Effect of the addition of municipal solid-waste compost on microbial biomass and enzyme activities in soil. Biol. Fertil. Soils, 10: p. 221.

Rajbir S, Sharma RR, Satyendra K, Gupta RK, Patil RT (2008). Vermicompost substitution influences growth, physiological disorders, fruit yield and quality of strawberry (*Fragaria × ananassa* Duch.). Bioresour. Technol. 99: 8507-8511.

Sainz MJ, Taboada-Castro MT, Vilarino A (1998). Growth, mineral nutrition and mycorrhizal colonization of red clover and cucumber plants growth in a soil amended with composted urban wastes, Plant Soil, 205: 85-92.

Senesi N, Saiz-Jimenez C, Miano TM (1992). Spectroscopic characterization of metal-humic acid-like complexes of earthworm-composted organic wastes. Sci. total Environ. 117/118: 111-120.

Tisdale JM, Oades JM (1982). Organic matter and water-stable aggregates in soil. J. Soil Sci. 33: p. 141.

Tomati U, Galli E (1995). Earthworms, soil fertility and plant productivity. Acta Zoological fennica, 196: 11-14.

Tomati U, Galli E, Grappelli A, Dihena G (1990). Effect of earthworm casts on protein synthesis in radish (*Raphanus sativum*) and lettuce (*Lactuca sativa*) seedlings. Biol. fert. Soil, 9: 288-289.

Zink TA, Allen MF (1998). The effects of organic amendments on the restoration of a disturbed coastal sage scrub habitat. Restoration Ecol. 6(1): 52-58.