The Effect of Spent Mushroom Compost on The Dry Matter And Mineral Content of Pepper (*Piper nigrum*) Grown in Greenhouse

M. Kubilay ÖNAL Bülent TOPCUOĞLU

Akdeniz University Vocational High School of Technical Sciences
Environmental Pollution and Control Department, 07058 Antalya TURKEY
konal@akdeniz.edu.tr

Abstract

This research was carried out to determine the effects of spent mushroom compost (SMC) as an organic material source for pepper grown in greenhouse soil. SMC was collected from mushroom cultivation plant in Korkuteli representative of the major mushroom growing area of Turkey. Pepper plants were grown in pots containing different amounts of SMC (corresponding to 0, 15, 30 and 60 T/ha, as dry weight basis). Red Mediterranean soil collected from the surface (0-30 cm) from the fields cropped in a wheat-corn rotation in Antalya Turkey was used as an experimental soil. The heavy metal content of untreated greenhouse soil was well within the accepted normal range of values. The effects of SMC on dry matter and N, P, K, Ca, Mg, Fe, Zn, Cu, Ni, Cd and Pb contents of pepper were determined. SMC applications caused statistically important effects on dry matter yield, and N, P, K, Fe and Zn contents in the pepper plant. SMC applications increased yield until to 30 ton/ha of SMC application, but higher application rates of SMC compost depressed plant growth. All spent mushroom compost treatments, except control were resulted higher mineral content. However, no important changes in heavy metals were detected. All metal concentrations were below the phytotoxic maximum limits. The best result for yield as regard to productivity was obtained at 30 ton/ha SMC applications. At 60 ton/ha SMC applications pepper yield was depressed due to the high salt content. This research showed that SMC could be applied greenhouse soil at the agronomic rates without heavy metal and salinity defects.

Key Words: SMC compost, heavy metals, pepper

Introduction

Spent mushroom compost (SMC) when added to soils can have a number of beneficial effects. SMC contains valuable plant nutrients and organic matter that can improve soil fertility. It can supply plant nutrients to the crop and thus replace inorganic fertilizer. Trials have shown that it is an excellent source of phosphorus, potassium and trace elements but needs supplementation with nitrogen for best results. Plant nutrient value of the SMC is examined by most of the researchers and it is indicated that the nutrient combination is similar to soil arrangements , based on the organic wastes, applied to the agricultural areas routinely such as cattle manure and compost (Stewart et. al., 1998; Kutuk et al., 1998).

The phytonutritive capacity of compost has often been demonstrated to be analogous to that of manure; the same level of productivity, both quantitatively and qualitatively, can be maintained by replacing manure with compost (Beyca et.al.,1993). However, SMC often contains high salt levels remaining from the fertilizer materials applied during mushroom cultivation. High or excessive soluble salts may be injurious to plants (Anonymous, 1995).

In this research, plant nutrient contents and heavy metal accumulations in the leaf and the fruit of pepper which treated with spent mushroom compost were observed.

Materials and methods

A pot experiment was carried out in the greenhouse and pepper plant was grown in soil treated with SMC. SMC was collected from mushroom cultivation plant in Korkuteli representative of the major mushroom growing area of Turkey. Greenhouse soil and SMC properties are shown Table 1.

In the experiment, plastic pots containing 10 kg soil were used. SMC was applied to experimental soil. After getting the fresh SMC, it had been treated in open air for 6 months, dried, and applied to the soil. SMC was applied pots as an oven-dry basis, corresponding at the following rates:

- SMC_0: no SMC application (Control)
- SMC_{15}: 15 ton/ha of SMC
- SMC_{30}: 30 ton/ha of SMC
- SMC_{60}: 60 ton/ha of SMC

Pots were arranged in a completely randomized design with four replicates. Before transplanting the plants, all treatments received supplemental fertilization at a rate of 160, 50 and 120 mg kg^{-1} of N, P and K, respectively.

Seedlings of pepper (*Piper nigrum var. Demre8*) were transplanted as one plant per pot. All pots were located in the greenhouse under controlled climatic conditions. Pots were maintained around field capacity by daily watering with distilled water. Fiftytwo days after transplanting, pepper plants were harvested. Leaf samples were dried at 65 ºC for 48 h for determination of plant analysis . In dried leaf samples total N were determined by Kjeldahl method. Plant tissues were ground and digested in aqua regia (1:3 HNO_3/HCl). In wet ashed leaf samples total P were determined by molibdophosphoric yellow colour method, total K, Ca, Mg, Fe, Zn, Mn, Cu, Cd, Ni abd Pb were determined by atomic absorption spectrophotometry (FAAS) under optimised measurement conditions.

Data were analyzed by standard ANOVA procedures for a randomized complete block design and least significant difference (LSD) at $P<0.05$ was used.

Results and Discussion

The heavy metal contents of untreated greenhouse soil and SMC (Table 1) are well within the accepted normal range of values. A comparison of metal contents of SMC with that of untreated soil showed that the metals Zn, Cu, Ni, Pb and Cd were not present in SMC in greater concentrations than in the soil. The heavy metal concentrations of SMC is below the levels indicated by the EU (CEC, 1986) for the agricultural use of waste organic material (sewage sludge).

The fruit yield and the concentrations of N, P, K, Ca, Mg, Fe, Mn, Zn, Cu, Ni, Pb, Cd and Cr in the leaves of pepper plant grown in SMC treatments, and also background (Penn. State Univ., 2003) and phytotoxic metal limits as defined by Kabata-Pendias (2000) are presented in Table 2.

The effect of spent mushroom compost on the fruit yield and N, P, K, Fe and Zn contents were found statistically important (Table 2). Plant fruit yield increased by SMC applications. The best result for yield as regard to productivity was obtained at 30 ton/ha SMC applications. Fruit yield decreased at 60 ton/ha of SMC applications, possibly by inreased salinity. N, P, K, Fe and Zn contents were increased by SMC applications. Chong et al. (1991), Wisniewska and Pankiewiez (1989) reported similar findings. As can be seen in Table 2, nitrogen content of pepper was below the background level. N content was increased by SMC applications. This increase was attributed to increased N availability of SMC (Rhoads and Olsen, 1995; Kutuk et al., 1999). All spent mushroom compost treatments, except control were resulted higher mineral content. However, no important changes in heavy metals were detected. All metal concentrations were below the phytotoxic maximum limits. Cd content of pepper were found below the sensitivity of analytical apparatus. This is because of low metal level of SMC.

Conclusion

The findings support that the SMC has positive effects on the pepper plant. For this reason, the use of SMC becomes widespread. Results showed that the use of the SMC in agricultural areas indicated that it has generally positive effects on pepper nutrient content. However, in the long-term SMC applications, the risks of salinity must be considered.

References

Anonymous, 1995. Guidelines for Compost Quality. The Canadian Council of Minesters of the Environment.

Beyca, J., De Chant, L., Conditt, M, Jones, B., 1993. Wet bag composting trial yields promising results. Biocycle, 34(4): 72-75.

C.E.C. (Council of the European Communities) 1986. Directive of 12 June 1986 on the protection of the environment, and in particular of the soil, when sewage sludge is used in agriculture (86/278/CEE). Official Journal of the European Communities, L181, 6-12.

Chong,C., Cıne, R.A., Rnker, D.L., Allan, O.B. 1991. Growth and mineral nutrient of containerized woody species in media amended with spent mushroom compost. J. of the American Soc. for Hort. Sci., 116(2):242-247.

Kabata-Pendias, A., Pendias, H. 2000. Trace elements in soils and plants. CRC Press, Boca Raton, FL.

Kutuk, C., Topcuoglu, B., Caycı, G. 1998. The effect of different growing media on growth of croton (codiaeum variegatum 'Petra') plant. M. Şefik Yeşilsoy International Symposium on arid region soil, September 21-24, 1998, Menemen İzmir, Turkey

Kutuk, C., Topcuoglu, B., Demir, K. 1999. Effects of different organic matters applied to soil on yield and some quality factors and mineral contents in spinach plants. Akdeniz University Journal of the Faculty of Agriculture, 12, 31-36.

Penn. State University agriculture analytical Services Laboratory (2003). Interpretive nutrient levels for plant analysis. Available: http://aasl.psu.edu/plant_nutrients.htm [2003, July 31].

Rhoads, F.M., Olsan, S.M. 1995. Crop production with mushroom compost. Proceedings of Soil and Crop Sci. Soc. of Florida, 54:53-57.

Stewart, D.P.C., Cameron, K.C., Cornforth, I.S., Sedcok, J.R. 1998. Effects of spent mushroom substrate on soil physical conditions and plant growth in an intensive horticultural system. Avusturalian Journal of Soil Research, 36(6):899-912.

Wisniewska, G.H., Pankiewicz, T. 1989. Evaluation of the suitability of spent mushroom substrate for tulip cultivation. Prace Instytutu Sadownictura kwiaciarstwa w skerniewicack, 14:7-13.

Table 1. The analytical characteristics of the experimental soil and SMC before treatment, and their pollutant limits.

Parameters	Soil	Limit values in soil [1]	SMC	Limit values in organic materials[1]
Texture	Loam		-	
pH- H_2O (1:5 w/v)	7.34		6.6	
EC. (1:5 v/w) dS m^{-1}	0.33		7.15	
$CaCO_3$, %	7.70		-	
Total N, %	0.13		2.17	
Organic Matter, %	2.20		66.6	
Zn, mg kg^{-1}	90[1]	150-300	266[1]	2500-4000
Cu, mg kg^{-1}	23	50-140	34	1000-1750
Ni, mg kg^{-1}	16	30-75	14	300-400
Pb, mg kg^{-1}	3	50-300	4	750-1200
Cd, mg kg^{-1}	*	1-3	*	20-40

*: Below detection limit (< 0.02 mg kg^{-1}), [1]: Total concentrations (mg kg^{-1} dry wt), (C.E.C., 1986)

Table 2. Plant nutrients and heavy metal contents of pepper treated with SMC.

Treatments	Fruit yield g/pot	N	P	K	Ca	Mg	Fe	Mn	Zn	Cu	Ni	Pb	Cd	Cr
		%					mg kg^{-1}							
SMC_0	285 d	3.24 d[1]	0.305 d	2.14c	3.25	0.59	79 b	67	22c	5	1.2	2.0	<0.02	0.05
SMC_{15}	315 c	3.67 c	0.359 c	2.31 b	3.15	0.51	75 b	71	31 b	7	1.4	2.7	<0.02	0.05
SMC_{30}	456 a	4.14 b	0.458 b	2.43 b	2.88	0.59	88 b	79	36 b	8	1.3	2.6	<0.02	0.05
SMC_{60}	388 b	4.67 a	0.472 a	2.51 a	3.66	0.62	117 a	77	42 a	9	1.6	2.7	<0.02	0.05
Significancy	**	**	**	*	Ns	ns	*	ns	*	ns	ns	ns	ns	ns
Background levels[2]		3.00	0.30	2.50	0.60	0.30	30	30	25	5	-	-	-	-
Phytotoxic levels[3]		-	-	-	-	-	-	-	100-400	20-100	10-100	30-300	5-30	5-30

**: P<0.01, *: P<0.05, ns: no significancy, [1]: Means within an amendment followed by the same letter are not significantly different at the 005 level, [2]: Pen. State Univ (2003) [3]: Kabata-Pendias (2000)