Asian Journal of Chemistry Vol. 17, No. 2 (2005), 829–834

Determination of Heavy Metal and Nutrient Contents and Potential Use of Tobacco Waste Compost in Vegetable Seedling Production

NAİF GEBOLOĞLU*, AYŞEGÜL DURUKAN and SEMA CAMCI ÇETİN†
Department of Horticulture, Faculty of Agriculture
Gaziosmanpaşa University, 60240, Tokat, Turkey
E-mail: naif@gop.edu.tr

The importance of organic waste usage has become crucial both in reducing environmental problems and facilitating this potential in organic farming. The objectives of this study were to compare nutrient and heavy metal contents of tobacco waste compost and investigate their effects on pepper, tomato, eggplant and cucumber seedling production. Compost media were compared with peat and tobacco waste with perlite, pumice, manure, quail manure and soil mixture in terms of nutrient and heavy metal. Results showed that heavy metal contents of medium were under the limit of hazard level. However, these media contained high level of nutrient contents, particularly N, P, K, Ca and Mg. EC and pH values in these media varied between 0.58–1.50 mmos·cm and 5.86–7.74, respectively. The results showed that tobacco waste compost may be used as an organic fertilizer due to the high nutrient and low heavy metal contents.

Key Words: Compost, Tobacco waste, Heavy metals, Nutrient, Vegetable seedling.

INTRODUCTION

Seedling production is the first step in vegetable production. The major component of growing media for vegetable seedling is peat[1] due to its physical and chemical properties[2]. Peat serves as an adequate medium having enough porosity and high cation exchange capacity for seedlings[1]. Peat also has certain disadvantages, *viz.*, pathogenic fungi (*Phytium, Fusarium, Rhizoctania,* etc.)[3] and high cost[1].

Compost can be used as peat substitute for seedlings production[4]. Solid waste management is an important issue for environmental concern. Tobacco waste can be used as a compost material with other composting ingredients. Tobacco waste compost, like other kinds of compost, has a potential substituting peat in seedling production. Tobacco plants can absorb high concentrations of cadmium which is

†Department of Soil Science, Faculty of Agriculture, Gaziosmanpaşa University, 60240, Tokat, Turkey.

considered as a toxic element for humans[5]. Tobacco waste contains many essential macro and micro elements for plant growth. N, P, K, Ca, Mg, Fe, Mn, Zn and Cu content of tobacco waste are 22800, 1037, 23800, 7832, 9625, 5250, 150, 125 and 110 mg kg^{-1}, respectively[6].

Now-a-days, many studies focus on the potential use of compost in seedling production. Different kinds of organic materials can be used for this purpose. Pine crust, grape waste[7], sawdust, plant residues[8] and manure[9,10] were used as compost material.

When the current studies are reviewed, it can be seen that tobacco waste compost has not been tested in growing of vegetable seedling as a substrate or pure material, but most plant waste has been used for this purpose[1, 3, 7, 11–14].

The objectives of this study were (i) to evaluate the possible use of tobacco waste compost as a seedling growing media, (ii) to test the potential substitution of peat media in seedling production, (iii) to investigate nutrient and heavy metal levels of tobacco waste compost and seedlings, and (iv) to show the factors that limit using tobacco waste compost in seedling production.

EXPERIMENTAL

The study was carried out in Tokat, Turkey in 2002 and 2003. Pepper (cv. Kandil), tomato (cv. Polaris F_1), eggplant (cv. Faselis F_1) and cucumber (cv. Huseyn F_1) were used in the trial.

Compost preparation: 65% tobacco waste obtained from tobacco factory, 18% manure, 13% grass and 4% straw were used in the preparation of tobacco waste compost. Compost material was mixed once a week. Compost was matured in 105 days under aerobic conditions. Peat was used as a control substitute in the trial. Different seedling growing media were prepared by adding various organic and inorganic materials into the tobacco waste compost. The media that were used in the experiment are: (1) peat, (2) tobacco dust compost (TC), (3) tobacco dust compost + peat (1 : 1) (TCP), (4) tobacco dust compost + perlite (1 : 1) (TCPE), (5) tobacco dust compost + pumice (1 : 1) (TCPU), (6) tobacco dust compost + soil (1 : 1) (TCS), (7) tobacco dust compost + manure + soil (2 : 1 : 1) (TCMS), and (8) tobacco dust compost + quail manure + soil (4 : 2 : 1) (TCQS).

EC and pH were measured in the growing medium. Some important nutrients such as N, P, K, Ca and Mg and heavy metals such as Cd, Pb, Cu and Zn were determined in seedlings and growing media.

Sample preparation: Pepper, tomato, eggplant and cucumber seedlings were washed with distilled water, cut into parts and dried in an electrical furnace at 105°C. After drying, the seedlings were ground in a mortar and kept in clean polyethylene bags for analysis. The growing substrates were placed in plastic bags and tied securely. Any visible plant and animal residues were removed from samples in the laboratory. Routinely, samples for the same physical and chemical analysis were sieved to pass through 2 mm sieve.

Sample preparation for element analysis: Seedling samples of 0.3 g each were digested using 10 mL of concentrated H_2SO_4 on a hot plate. H_2O_2 was added and the samples were then heated until a clear solution was obtained. The same procedure was repeated several times. The samples were filtered and diluted to 50 mL using distilled water.

Substrates of 0.5 g each were digested using 5 mL of H_2O_2 on a hot plate. The same procedure was repeated until all organic matter was removed. After that, the substrate samples were digested with 10 mL HCl/HNO_3 (3 : 1) acid mixture adding the acid mixture several times. The samples were filtered and diluted to 100 mL using distilled water. Elements were determined by ICP. Kjeldahl method was used for the analysis of nitrogen level[15].

The study was carried out as a randomized complete block design with three replications. EC and pH levels of medium were determined in a solution (1/50) by EC meter and pH meter, respectively.

RESULTS AND DISCUSSION

The best seedling growth was obtained from peat medium. TCP was the second most promising medium in our study. In this experiment, seed germination was quite poor in TC media. Also, seedling growth in TC media was not at the expected level. No seedling grown in TC media was observed for pepper and tomato seedlings.

We found high cadmium content in TCQS media. There was no significant difference between the other media. Concentrations of lead were found higher in peat, TC, TCP, TCPE and TCQS than those of the other three media. Copper contents of TCS, TCQS, TCMS, TC and TCPE, and zinc contents of TCQS were statistically higher than those of the other media (Table-1).

TABLE-1
HEAVY METAL CONTENTS IN SEEDLING GROWING MEDIA (mg kg^{-1})

Growing media	Cd	Pb	Cu	Zn
Peat	0.62 b	3.18 ab	19.5 c	47.5 d
TC	0.78 b	3.64 a	46.7 ab	91.3 bc
TCP	1.10 b	3.32 ab	38.8 b	89.3 bc
TCPE	1.00 b	3.02 b	42.6 ab	107.5 b
TCPU	0.64 b	1.52 d	25.4 c	62.3 d
TCS	0.68 b	2.44 c	51.6 a	94.4 bc
TCMS	0.62 b	1.92 cd	49.7 ab	86.7 c
TCQS	3.04 a	3.08 ab	51.0 a	153.3 a
LSD	0.83†	0.56†	12.4†	18.6†

†Significant at $P \leq 0.01$.

Peat contained the lowest nutrient levels, while TC and TC mixture of other medium contained more nutrient level. For instance, concentrations of N and K in TC were 3.64% and 99.16 g kg^{-1}, respectively (Table-2).

TABLE-2
NUTRIENT CONTENTS OF SEEDLING GROWING MEDIUM

Growing media	N (%)	P (g kg^{-1})	K	Ca	Mg
Peat	2.79 c	1.21 c	76.12 ab	17.40 d	2.85 g
TC	3.64 a	1.75 b	99.16 a	40.13 bc	4.48 b
TCP	3.35 ab	1.80 b	82.54 ab	34.90 c	3.97 e
TCPE	3.11 bc	2.26 a	86.87 ab	41.25 bc	4.33 d
TCPU	3.50 ab	1.06 c	73.24 b	13.57 d	3.41 f
TCS	3.33 ab	1.78 b	74.27 b	46.91 b	4.67 a
TCMS	3.34 ab	1.87 b	82.40 ab	43.29 bc	4.66 a
TCQS	3.48 ab	1.86 b	82.92 ab	57.25 a	4.39 c
LSD	0.5*	0.26†	20.29†	9.32†	0.14†

* Significant at $P \leq 0.05$; † Significant at $P \leq 0.01$.

Heavy metal contents of seedlings have varied due to their depending on different plant species (Table-3). Pepper seedlings had the highest Cd, Pb and Zn content whereas tomato seedlings had the highest Cu content.

TABLE-3
HEAVY METAL CONTENTS OF SEEDLINGS IN THE PLANT SPECIES (mg kg^{-1})

Vegetables	Cd	Pb	Cu	Zn
Pepper	1.51 ± 0.17	1.22 ± 0.21	11.55 ± 0.49	94.72 ± 5.63
Tomato	0.93 ± 0.09	1.18 ± 0.18	14.34 ± 0.89	79.77 ± 5.60
Eggplant	1.42 ± 0.13	0.83 ± 0.12	11.11 ± 0.37	83.00 ± 2.51
Cucumber	0.99 ± 0.09	1.08 ± 0.19	13.35 ± 0.60	88.09 ± 3.76

Also, the highest N concentration was determined in eggplant seedlings (3.93%), the lowest was in tomato (2.87%). Highest P, K, Ca and Mg were determined in cucumber (3.93 g kg^{-1}), in pepper (62.69 g kg^{-1}), in cucumber (15.26 g kg^{-1}) and in cucmber (3.53 g kg^{-1}), respectively (Table-4).

TABLE-4
NUTRIENT ELEMENTS OF SEEDLINGS IN THE PLANT SPECIES

Vegetables	N (%)	P (g kg^{-1})	K	Ca	Mg
Pepper	3.27 ± 0.10	3.54 ± 0.24	62.69 ± 2.76	10.37 ± 1.02	3.40 ± 0.04
Tomato	2.87 ± 0.10	3.54 ± 0.23	52.57 ± 2.51	11.47 ± 0.51	3.42 ± 0.04
Eggplant	3.39 ± 0.13	3.48 ± 0.22	59.55 ± 1.89	9.48 ± 0.47	3.10 ± 0.05
Cucumber	3.09 ± 0.09	3.93 ± 0.24	58.35 ± 3.57	15.26 ± 0.73	3.53 ± 0.04

In this study pH levels of peat, TC, TCP, TCPE, TCPU, TCS, TCMS and TCQS were 5.86, 6.86, 6.87, 6.91, 7.35, 6.50, 7.16 and 7.74 respectively. EC levels of these media were 1.42, 1.50, 1.33, 1.35, 1.24, 0.58, 0.86 and 1.12 respectively.

It has been a common practice to use mature organic and inorganic materials to sustain physical and chemical properties of soil and preparation of seedling media in agricultural production. This will lead to the prevention of environmental pollution and facilitate usage of organic farming. Rice hull[16–18], pine bark, grape marc[7], peat, zeolite, green material[11], peat, vermiculit, polystyrene[18], peat, perlite, compost[10], composted sawdust[19], various municipal solid waste[13], etc. were used for preparation of vegetable seedling media. However, it is interesting to note that tobacco waste compost was not used for this purpose.

Common ranges for Pb and Cd in plants are 0.5–10.0 and 0.05–2.0 $\mu g\ g^{-1}$ respectively[20]. In our study Pb and Cd concentrations in seedlings which grow in tobacco waste compost are between 0.76–0.78 and 0.78–1.62 mg kg^{-1} respectively. Pb and Cd limits must be 50–300 and 1–3 mg kg^{-1} according to European Union limits for agricultural soils[21]. In this study, Pb and Cd levels are found to be 3.64–0.78 mg kg^{-1}, which are under European Union limits for agricultural activities.

Brohi and Durak[6] reported that the amount of macro and micro nutrients in tobacco waste provide optimum conditions for plant growth. However, higher concentration of these nutrients except magnesium have been found in the present study, which can be attributed to the preparation of compost from tobacco waste.

We observed that using tobacco waste compost alone, seedling development was quite slow and seedlings showed poor quality. Also, an inadequate seedling development on pepper and tomato seeds was observed after germination due to the lower water holding capacity of tobacco waste compost. However, when perlite or pumice was added, which has high water holding capacity than tobacco waste compost, seedling development was improved.

No heavy metals or nutrient deficiency problems on tobacco waste compost have been observed. However, it has been shown that the more common practice of peat growing medium for pepper, tomato, eggplant and cucumber seedling results in more vigorous and healty growth. Thus, compost obtained from tobacco waste is not convenient for seedling production. On the other hand, tobacco waste compost can be used as an organic fertilizer in vegetable production due to the high nutrient contents and lack of heavy metals.

It is important to pay attention to tobacco mosaic virus (TMV) while preparing compost from tobacco waste.

REFERENCES

1. M. Raviv, B. Zaidman and Y. Kapulnic, *Compost Sci. Utilization*, 46 (1998).
2. M. Raviv, Y. Chen and Y. Inbar, in: Y. Chen and Y. Avnimelech (Eds.), The Use of Peat and Composts as Growth Media for Container-grown Plants in the Role of Organic Matter in Modern Agriculture, Martinus-Nijhoff, Dordrecht, Netherlands, pp. 257–287 (1986).

3. H.A.J. Hoitink and G.A. Kuter, in: Y. Chen and Y. Avnimelech (Eds.), Effects of Composts in Growth Media on Soilborne Plant Pathogens in the Role of Organic Matter in Modern Agriculture, Martinus-Nijhoff, Dordrecht, Netherlands, pp. 289–306 (1986).
4. H.A.J. Hoitink and P.C. Fahy, *Ann. Rev. Phytopathol.*, **24**, 93 (1986).
5. J. Tancogne, R. Schiltz, R. Truhout, J.D. Claude and J. Chouteau, *CORESTA Information Bulletin 1988 Congress,* China (9–13 Oct., 1988).
6. A. Brohi and A. Durak, Tütün tozunun organik gübre olarak değerlendirilmesi, Türkiye Tütüncülüğü ve Geleceği Sempozyumu, S., Tokat, pp. 263–278 (1986) (in Turkish).
7. M. Reis, F.X. Martinez, M. Soliva and A.A. Monterio, *Acta Horticult.*, **469**, 263 (1998).
8. O.M. Sawan, A.M. Eissa and A.F. Abau-Halid, *Acta Horticult.*, **491**, 369 (1999).
9. V. Şeniz, *Acta Horticult.*, **366**, 243 (1994).
10. R.Z. Eltez, A. Gül and Y. Tüzel, *Acta Horticult.*, **366**, 257 (1994).
11. V. Markovic, M. Djuroka and Z. Ilin, *Acta Horticult.*, **462**, 163 (1997).
12. V. Markovic, M. Djuroka, Z. Ilin and B. Lazic, *Acta Horticult.*, **533**, 113 (2000).
13. N.E. Roe, P.J. Stoffella and D. Graetz, *J. Am. Soc. Horticult. Sci.*, **122**, 427 (1997).
14. C. Lin and G.X. Rui, *China Vegetables*, **2**, 15 (2000).
15. J.M. Bremner, Inorganic Forms of Nitrogen: Methods of Soils Analysis. Part 2: American Society of Agronomy, Inch. Publisher, Madison, Wisconsin (1965).
16. L. Simon, L. Byoungyil, K. Kwangyong and S. Jungeek, *J. Korean Soc. Horticult. Sci.*, **41**, 249 (2000).
17. O.M. Sawan, M.S. El-Beltagy, S.A. Mohammedien, A.S. El-Beltagy and M.A. Maksoud, *Acta Horticult.*, **190**, 515 (1986).
18. R.M. Hellal, A.M. Shahenn, N.M. Omar and A.R. Mahmoud, *Egypt. J. Horticult.*, **23**, 129 (1996).
19. O.M. Sawan and A.M. Eissa, *Acta Horticult.*, **434**, 127 (1996).
20. D.B. Levy, E.F. Redente and G.D. Uphoff, *Soil Sci.*, **164**, 363 (1999).
21. C. Gisbert, R. Ros, A. DeHaro, D.J. Walker, M.P. Bernal, R. Serrano and J. Navarro-Avino, *Biochem. Biophys. Res. Commun.*, **303**, 440 (2003).

(*Received*: 08 April 2004; *Accepted*: 22 November 2004) AJC-4013