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Influence of composted tobacco waste and farmyard manure applications on the yield and nutrient composition of lettuce (*Lactuca sativa* L. var. capitata)

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Abstract

The use of organic wastes in agriculture, forestry and land reclamation has been increasingly identified as an important issue for soil fertility, soil conservation and residue disposal. Using organic wastes in agriculture helps not only to dispose these materials economically, but also reduces negative effects on the environment. In the present study, composted tobacco waste (CTW) combined with farmyard manure (FM) at different ratios was applied to Typic Xerofluvent soil, and the influence of these amendments on the yield and nutrient composition of butter head letttuce (*Lactuca sativa* L. var. capitata) were investigated. The experiment was conducted in 18 parcels in a randomized-block design with three replications at the Agriculture Faculty's Research Farm of Ege University in Menemen plain, in the Western Anatolia Region of Turkey (38°58′35.51″-38°58′36.03″N; 27°03′84.56″-27°03′89.81″E). Organic materials were applied to the soil after composting. The treatments were (1) control, (2) 12.5 t ha^{-1} FM + 37.5 t ha^{-1} CTW, (3) 25 t ha^{-1} FM + 25 t ha^{-1} CTW, (4) 50 t ha^{-1} FM, (5) 50 t ha^{-1} CTW, and (6) 37.5 t ha^{-1} FM + 12.5 t ha^{-1} CTW. The maximum yield was obtained during the 1st vegetation period (62,7 t ha^{-1}) in the 100 % CTW application. On account of the 2nd vegetation period's coinciding with winter and the coldness of the months December, January and February, there happened a slowdown in the lettuce yield. The highest total yield of lettuce in both vegetation periods (102.7 t ha^{-1}) was determined in 100% CTW application parcels. The lower lettuce yields were determined in the control parcels. CTW and FM applications raised N, P, K Ca, Mg, Na, Fe, Zn and Mn contents of the lettuce. According to the results obtained, it can be said that CTW can be used in agricultural fields just like FM.

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Introduction

Increase of population and the industrial development produced an enormous amount of organic residues that generate great environmental problems nowadays. Potential solution is better use of organic residues resulting from human activities, such as sewage sludge, manure and mankind own organic residues, such as tobacco waste. The appropriate agricultural use of organic wastes can become advantageous for the humankind, because it allows recycling, lessening the pollution problems, as well as the improvement of the physical conditions, chemistries and biotic of the soils (Brito et al., 2007). Benefits of organic wastes and

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compost amendments to soil have been reported by many researchers (Roig et al., 1987; Doran and Parkin, 1994; Darwish et al., 1995; Drinkwater et al., 1995; Stamatiadis et al., 1999; Wang et al., 2003; Kızılkaya, 2005, 2008; Delibacak et al., 2009; Candemir and Gülser, 2010; Gülser and Candemir, 2012; Cercioğlu et al., 2014). Nevertheless, it is fundamental to control and limit the environmental impact of these practices since they can result in organic or inorganic contamination of natural resources. Among the pollutants, heavy metals have been critically examined since they can be toxic to humans, animals and plants (Baize and Sterckeman, 2001).

Farmyard manure (FM), which is the most useful organic matter, is provided from various animal wastes. Masood et al., (2014) reported that short-term application of higher FM levels improves soil properties. Furthermore, only the application of FM at higher rates significantly increases the nutrient uptake of maize plants due to improved soil properties. Since FM is not found in sufficient amounts in farms and it is an expensive material, other organic materials can be used instead of manure to improve soil properties and plant nutrients in soil. Tobacco solid waste is classified as an agroindustrial waste. Direct use of tobacco waste could create an unfavorable soil environment; however, composting tobacco waste could accelerate the breakdown of nicotine and result in the production of a less toxic and more useful organic amendment (Adediran et al., 2004).

Turkish soils are known to be widely deficient in N, P and trace elements, and have low rates of organic matter (OM). Therefore, OM and macronutrients and micronutrients concentrations of Turkish soils can be increased by using CTW. In the present study, composted tobacco waste (CTW) combined with FM at different ratios was applied to soil, and the influence of these amendments on the yield and nutrient composition of butter head lettuce (*Lactuca sativa* L.) were investigated.

Material and Methods

Experimental site

The experiment was conducted at the Agriculture Faculty's Research Farm of Ege University in Menemen plain, Izmir, Turkey (38°58′35.51″-38°58′36.03″N; 27°03′84.56″-27°03′89.81″E). The experimental site is in the Western Anatolia region of Turkey, where the Mediterranean climate prevails with a long-term mean annual temperature of 16.9°C. Long-term mean annual precipitation is 536.8 mm, representing about 75% of rainfalls during the winter and spring, and the mean relative humidity is 57%. Long-term mean annual potential evapotranspiration is 1570 mm (IARTC, 2012). The investigated soil is characterized by loam texture with slightly alkaline reaction and classified as a Typic Xerofluvent (Soil Survey Staff, 2006). Some physical and chemical properties and macronutrients and micronutrients in the experimental soil are given in Table 1.

Table 1. Some physical and chemical properties of the experimental soil (0-30 cm)

Parameter	Value
Soil texture	Loam
Sand (%)	44.26
Silt (%)	44.13
Clay (%)	11.61
pH	7.52
Total soluble salt (%)	0.085
CaCO3 (%)	5.38
Organic matter (%)	2.53
Total N (%)	0.129
Available P (mg kg^{-1})	8.88
Available K (mg kg^{-1})	447.2
Available Ca (mg kg^{-1})	2752
Available Mg (mg kg^{-1})	529.4
Available Na (mg kg^{-1})	217.9

Field experiment

The experiment was conducted in 18 parcels in a randomized-block design with three replications. The parcel size was 3×2 m. The organic materials were CTW and FM. The general properties of the organic materials are given in Table 2. The treatments were (1) control, (2) 12.5 t ha^{-1} FM + 37.5 t ha^{-1} CTW, (3) 25 t ha^{-1} FM + 25 t ha^{-1} CTW, (4) 50 t ha^{-1} FM, (5) 50 t ha^{-1} CTW, and (6) 37.5 t ha^{-1} FM + 12.5 t ha^{-1} CTW. Tobacco waste was taken from the Izmir Kemalpasa Socotab Cigarette Factory, and FM was obtained from the

Agriculture Faculty's Research Farm, Ege University, Menemen. Both materials were applied to the soil after composting. At the beginning of the experiment, 50 t ha^{-1} materials were applied to the soil because lettuce plants need 50-100 kg N ha^{-1} (IFA, 1992). Five hundred forty lettuce seedlings were planted in the first vegetation period by furrow irrigation. After that, irrigation method was changed to drip irrigation. The first harvest was made by hands. Similarly, during the second vegetation period, five hundred forty lettuce seedlings were planted by irrigation, and they were not irrigated until the end of the harvest. The second harvest was performed again by hands.

Table 2. Some properties of composted tobacco waste (CTW) and farmyard manure (FM)

Parameter	CTW	FM
pH	9.17	8.70
EC (dSm^{-1})	40	38.5
Org. C (%)	37.87	39
OM (%)	65.3	67.2
C/N	17.37	16.5
CaCO3 (%)	2.43	2.09
60 ◦C water content (%)	7.19	5.50
105 ◦C water content (%)	29.79	25.13
Total N (%)	2.18	2.35
Total P (%)	0.49	0.58
Total K (%)	2.688	3.072
Total Ca (%)	1.287	1.521
Total Mg (%)	0.655	0.615
Total Na (%)	0.255	0.281

Soil and plant sampling and analyses

During the experiment, soil samples (0-30 cm) were taken from the center of each parcel after one week of planting and before first (I) and second (II) harvests. The samples were air dried and sieved through 2 mm sieve. Particle-size distribution was determined according to Bouyoucos (1962). Gravimetric water content of moist FM and CTW were determined according to Jury et al. (1991). Total salt, OM concentration, $CaCO_3$, pH, total N, P, K, Ca, Mg, Na, Fe, Cu, Mn and Zn, concentrations of soil and CTW and FM and butter head lettuce samples were all determined according to Page et al. (1982). Available P was determined by the Mo blue method in a $NaHCO_3$ extract (Olsen et al., 1954). Available Ca, Mg, K and Na were analyzed with 1N NH_4OAc extract method. Ca, K and Na were determined by flame emission spectrometry and Mg was determined by flame atomic absorption spectrometry (AAS) (Kacar, 1994). Fe, Mn, Zn and Cu were extracted using DTPA (diethylene triamine pentaacetic acid) solution (Lindsay and Norwell, 1978). The concentrations of these elements in the extracts were determined by AAS (AOAC, 1990).

Statistical Analysis

Analysis of variance (ANOVA) was performed using the Statistical Package for the Social Sciences, version SPSS 17.0. Treatment differences between mean values of parameters were evaluated by one-way ANOVA followed by Duncan's test of significance at $P \leq 0.05$ (SPSS 17.0, 2008).

Results and Discussion

Influence of CTW and FM applications on grown lettuce yield in Typic Xerofluvent soil

Influence of CTW and FM applications on grown lettuce yield in Typic Xerofluvent soil are given in Table 3.

Table 3. Influence of composted tobacco waste (CTW) and farmyard manure (FM) applications on the lettuce yield

Treatments	Lettuce yield (t ha^{-1})		
	First harvest	Second harvest	Total yield
Control	50.7 b	31.0 c	81.7 b
25% FM+75% CTW	60.8 a	38.0 ab	98.8 a
50% FM+50% CTW	59.9 a	37.7 ab	97.6 a
100%FM	60.9 a	37.4 ab	98.4 a
100% CTW	62.7 a	39.9 a	102.7 a
75% FM+25% CTW	60.1 a	36.0 b	96.2 a

Means for CTW and FM rates applied in soil in the same period followed by the different letters are significantly different (Duncan; P ≤ 0.05)

In accordance with the controls, CTW and FM applications have increased the yield of lettuce statistically. The maximum yield was obtained during the 1st vegetation period (62.7 t ha^{-1}) in the 100 % CTW application. On account of the 2nd vegetation period's coinciding with winter and the coldness of the months December, January and February, there happened a slowdown in the lettuce yield. The highest total yield of lettuce in both vegetation periods (102.7 t ha^{-1}) was determined in 100% CTW application parcels. The lower lettuce yields were determined in the control parcels at the 1st and 2nd harvest as 50.7 and 31.0 t ha^{-1} respectively. Therefore the lowest total yield was obtained in the control as 81.7 t ha^{-1} (Table 4). Gunes et al. (2014) reported that application of biochar and poultry manure to soil significantly increased lettuce growth.

Table 4. Influence of composted tobacco waste (CTW) and farmyard manure (FM) applications on the mineral composition of lettuce

Applications	In the samples of 1st lettuce harvest	In the samples of 2nd lettuce harvest	In the samples of 1st lettuce harvest	In the samples of 2nd lettuce harvest
	N (%)		P (%)	
Control	2.35 c	2.74 b	0.57 b	0.61 b
25% FM+75% CTW	3.08 a	3.18 a	0.73 a	0.71 a
50% FM+50% CTW	3.01 ab	2.98 ab	0.68 a	0.72 a
100%FM	2.89 ab	3.38 a	0.71 a	0.73 a
100% CTW	3.01 ab	3.08 ab	0.66 a	0.70 a
75% FM+25% CTW	2.62 b	3.22 a	0.68 a	0.73 a
	K (%)		Ca (mg kg^{-1})	
Control	7.42 ab	4.60 a	7049 d	5506 e
25% FM+75% CTW	7.86 a	4.98 a	7550 c	6433 cd
50% FM+50% CTW	7.93 a	5.07 a	7906 b	6506 bc
100%FM	7.97 a	5.35 a	8125 a	6836 a
100% CTW	7.67 ab	4.91 a	7932 ab	6320 d
75% FM+25% CTW	7.90 a	5.19 a	7963 ab	6676 ab
	Mg (mg kg^{-1})		Na (mg kg^{-1})	
Control	2102 b	1318 c	4179 c	1334 b
25% FM+75% CTW	2187 ab	1585 ab	4383 b	1429 ab
50% FM+50% CTW	2353 a	1452 abc	4424 ab	1477 a
100%FM	2183 ab	1418 bc	4519 a	1522 a
100% CTW	2300 ab	1652 a	4343 b	1432 a
75% FM+25% CTW	2228 ab	1452 abc	4419 ab	1499 a
	Fe (mg kg^{-1})		Cu (mg kg^{-1})	
Control	145.8 c	82.6 c	10.4 d	12.6 c
25% FM+75% CTW	192.4 ab	106.2 ab	18.1 bc	18.9 b
50% FM+50% CTW	183.3 b	101.2 ab	18.9 abc	21.3 a
100%FM	178.5 b	92.6 bc	19.8 a	21.0 a
100% CTW	207.2 a	112.9 a	18.0 c	19.1 b
75% FM+25% CTW	182.0 b	97.2 abc	19.6 ab	20.3 ab
	Zn (mg kg^{-1})		Mn (mg kg^{-1})	
Control	16.0 c	26.6 d	33.1 b	24.5 b
25% FM+75% CTW	21.3 ab	35.3 a	38.5 a	26.7 ab
50% FM+50% CTW	21.2 ab	32.3 abc	38.4 a	26.8 ab
100%FM	18.3 bc	30.3 c	39.8 a	27.2 a
100% CTW	24.2 a	33.6 ab	39.2 a	25.3 ab
75% FM+25% CTW	19.2 b	30.6 bc	39.1 a	26.4 ab

Means for CTW and FM rates applied in soil in the same period followed by the different letters are significantly different (Duncan; P ≤ 0.05)

Influence of CTW and FM applications on the nutrient composition of lettuce

Influence of CTW and FM applications on the nutrient element composition of lettuce were given in the Table 4. N content of the lettuce samples showed an increase in both periods statistically with CTW and FM applications. Minimum N content was determined in the plant samples that were taken from the control parcels. While the maximum value was obtained in 25% FM+75% CTW applications with 3.08% N, the minimum value was determined in the control parcels as 2.35 % N. Tepecik et al. (2014) found that total N contents varied between 2.11 % and 2.70 % in the conventionally grown basil and between 2.21 % and 2.39 % in the organically grown basil.

P content of the lettuce in both period samples showed an increase with CTW and FM applications. Statistically, while the control was in a separate group with the lowest P content, other applications took place within the same group. Gunes et al. (2014) determined that phosphorus concentration of the lettuce leaves significantly increased by poultry manure and biochar treatments.

K content of the lettuce samples of the first period showed increase with CTW and FM applications. Besides that, while statistically the control and 100% CTW applications are found in the same group with the minimum K contents (7.42%; 7.62%), the maximum K content was determined 100% FM application (7.97%) and other applications took place in different group. Gunes et al. (2014) reported that Lettuce K concentrations were increased in response to poultry manure and biochar.

The effect of 100% FM application on Ca content of lettuce samples showed the highest increase in both periods (8125-6836 mg kg^{-1}) and took place in a different group statistically. Minimum Ca quantities among all applications were obtained from control samples (7049-5506 mg kg^{-1}).

The highest Mg quantity in the first period lettuce samples was determined in 50% CTW+50% FM application (2353 mg kg^{-1}). On the other hand, the highest Mg quantity in second period lettuce samples was (1652 mg kg^{-1}) in 100% CTW application and these applications statistically took place in different groups. The minimum Mg quantities in both periods were determined in control parcels (2102-1318 mg kg^{-1}) and statistically took place in different group from other applications.

While the highest Na quantity of the lettuce samples in the first period was determined in 100% FM application (4519 mg kg^{-1}), the minimum Na quantity was found (4179 mg kg^{-1}) in control samples. In second period lettuce samples, the Na quantity in lettuce was generally decreased. The Na quantity which was minimum in the control with 1334 mg kg^{-1} meanwhile the maximum quantity of Na was determined as 1522 mg kg^{-1} with 100% FM application. The Na content of the second period lettuce samples was low stemmed from the fact that no irrigation was done because the amount of rainfall in this period was high which caused the washing of Na in the soil. The Na content of first period samples was determined as higher than the second period samples due to the Na that came from irrigation water and applications.

Maximum Fe quantity of lettuce samples in both periods was determined in 100% CTW aplication (207.2-112.9 mg kg^{-1}) and this aplication statistically took place in different group distinct from control and other aplications. As for the minimum Fe quantity was determined again in the lettuce samples that were taken from control parcels (145.8-82.6 mg kg^{-1}).
When Cu contents of the lettuce samples were examined, the maximum value in the first period was obtained in 100% FM application with 19.8 mg kg^{-1} and in the second period, they were obtained in 100% FM (21,0 mg kg^{-1}) and 50% CTW+50% FM (21.3 mg kg^{-1}) applications. Cu quantity of both periods was found minimum in the control samples and the control took place statistically in a different group.

The maximum Zn content of the first period lettuce samples was determined in the 100% CTW application (24.2 mg kg^{-1}) and statistically this application took place in a different group from control and other applications. As for the second period lettuce samples, the maximum Zn value was determined in the 25% FM+75% CTW application (35.3 mg kg^{-1}). The minimum Zn quantities were found in the control samples in both periods (16.0-26.6 mg kg^{-1}).

Mn content of lettuce samples increased according to the control in the first period and while all of the applications took place statistically in the same group, the control samples took place in different group. Maximum Mn content of first and second period samples was determined in 100 %FM application as 39.8-27.2 mg kg^{-1}, respectively.

In a study about lettuce with different organic fertilizers, Demir et al. (2003) reported that average Mg, Na, Fe, Cu, Mn and Zn content of lettuce were determined as mg kg^{-1} 2321, 1007, 172.39, 12.51, 61.99 and 45.33, respectively. The quantitites of nutritional elements in the lettuce samples apart from N, P, Cu, Zn and Mn were determined as much higher in the first period products than the second period products. This case is also the same with lettuce yield. The reason behind this can be attributed to the fact that the second period lettuce production happened in winter and metabolic activities showed a decrease because of the decrease of the temperatures.

Conclusion

CTW and FM applications raised the lettuce yield and N, P, K Ca, Mg, Na, Fe, Zn and Mn contents of the lettuce. According to the results obtained, it can be said that CTW can be used in agricultural fields just like FM. Especially the 25%+75% CTW and 100% CTW applications showed more important effects. These results indicate that CTW can function as an alternate organic additive (soil improver) so as to enhance the amount of organic matter in the soils of Aegean Region that has the Mediterranean climate and contain low amount of organic matter. It is useful to apply tobacco wastes on soil by composting them because of their high content of nicotine. For the applications without composting, it is suggested to wait for at least a month for sowing-planting process after the application. Some other studies that will reveal the positive, long-term affects of CTW should also be carried out so as to protect and enhance the soil quality.

References

Adediran, J.A., Mnkeni, P.N.S., Mafu, N.C., Muyima, N.Y.O., 2004. Changes in chemical properties and temperature during the composting of tobacco waste with other organic materials, and effects of resulting composts on lettuce (*Lactuca sativa* L.) and spinach (*Spinacea oleracea* L.). *Biological Agriculture & Horticulture: An International Journal for Sustainable Production Systems* 22:101-119.

AOAC, 1990. Official methods of analysis In: Helrich K (ed) Association of official analytical chemists. Washington, DC. USA.

Baize, D., Sterckeman, T., 2001. Of the necessity of knowledge of the natural pedo-geochemical background content in the evaluation of the contamination of soils by trace elements. *Science of The Total Environment* 264:127–139.

Bouyoucos, G.J., 1962. A recalibration of the hydrometer method for making mechanical analysis of the soils. *Agronomy Journal* 54 (5):419-434.

Brito, J., Chada, I., Pinto, P., Guerrero, C., Beltrão, J., 2007. Use of the pulp of the sugarcane as soil organic amendment and its possible use as substratum. 3rd WSEAS/IASME International Conference on Energy, Environmental Ecossystems & Sustainable Development', Crete Island, Greece, 24-26 July 2007, pp. 137-140.

Candemir, F., Gülser, C., 2010. Effects of different agricultural wastes on some soil quality indexes at clay and loamy sand fields. *Communications in Soil Science and Plant Analysis* 42(1): 13-28.

Cercioğlu, M., Okur, B., Delibacak, S., Ongun, A.R., 2014. Changes in physical conditions of a coarse textured soil by addition of organic wastes. *Eurasian Journal of Soil Science* 3(1):7-12.

Darwish, O.H., Persaud, N., Martens, D.C., 1995. Effect of long-term application of animal manure on physical properties of three soils. *Plant and Soil* 176:289-295.

Delibacak, S., Okur, B., Ongun, A.R., 2009. Influence of treated sewage sludge applications on temporal variations of plant nutrients and heavy metals in a Typic Xerofluvent soil. *Nutrient Cycling in Agroecosystems* 83(3): 249-257.

Demir, H., Gölükçü, M., Topuz, A., Özdemir, F., Polat, E., Şahin, H., 2003. Yedikule ve iceberg tipi marul çeşitlerinin mineral madde içeriği üzerine ekolojik üretimde farklı organik gübre uygulamalarının etkisi. *Akdeniz Üniversitesi Ziraat Fakültesi Dergisi* 16:79-85 (in Turkish).

Doran, J.W., Parkin, T.B., 1994. Defining and assessing soil quality. In: Defining Soil Quality for a Sustainable Environment. J.W. Doran, D.C. Coleman, D.F. Bezdicek, B.A. Stewart (Eds). Soil Science Society of America Special Publication Madison, WI: ASA-SSSA. 35, 3-21.

Drinkwater, L.E., Letourneau, D.K., Workneh, F., van Bruggen, A.H.C., Shennan, C., 1995. Fundamental differences between conventional and organic tomato agroecosystems in California. *Ecological Applications* 5: 1098–1112.

Gunes, A., Inal, A., Taskin, M.B., Sahin, O., Kaya, E.C., Atakol, A., 2014. Effect of phosphorus-enriched biochar and poultry manure on growth and mineral composition of lettuce (Lactuca sativa L. cv.) grown in alkaline soil. *Soil Use and Management* 30:182-188.

Gülser, C., Candemir, F., 2012. Changes in penetration resistance of a clay field with organic waste applications. *Eurasian Journal of Soil Science* 1(1):16-21.

IARTC, 2012. Weather Station Climate Datas of International Agricultural Research and Traning Center. Menemen, İzmir.

IFA, 1992. World fertilizer use manual. Paris: International Fertilizer Industry Association.

Jury, W.A., Gardner, W.R., Gardner, W.H., 1991. Soil Physics, 5th edition. John Wiley & Sons INC., ISBN-0-471-83108-5, New York. USA. 327 p.

Kacar, B., 1994. Chemical analysis of plant and soil: III Soil analysis. Ankara University, Faculty of Agriculture, Education Res. & Extension Found. Publication No. 3 Ankara, Turkey. (in Turkish)

Kızılkaya, R., 2005. The role of different organic wastes on zinc bioaccumulation by earthworm *Lumbricus terrestris* L. (Oligochaeta) in successive Zn added soil. *Ecological Engineering* 25(4): 322-331.

Kızılkaya, R., 2008. Dehydrogenase activity in *Lumbricus terrestris* casts and surrounding soil affected by addition of different organic wastes and Zn. *Bioresource Technology* 99(5): 946–953.

Lindsay, W.L., Norwell, W.A., 1978. Development of DTPA soil test for zinc, iron, manganese and copper. *Soil Science Society America Journal* 42: 421-428.

Masood, S., Naz, T., Javed, M.T., Ahmed, I., Ullah, H., Iqbal, M., 2014. Effect of short-term supply of farmyard manure on maize growth and soil parameters in pot culture. *Archives of Agronomy and Soil Science*. 60: 337-347.

Olsen, S.R., Cole, C.V., Watanabe, F.S., Dean, L.A., 1954. Estimation of available phosphorus in soils by extracting with sodium bicarbonate. USDA Circ. 939. U.S. Gov. Print. Office.

Page, A.L., Miller, R.H. and Keeney, D.R. (Eds.), 1982. In: Methods of soil analysis. Part 2. Chemical and microbiological properties, 2nd ed. Agron. Monogr. 9. ASA-SSA, Madison, USA.

Roig, A., Lax, A., Costa, F., Cegarra, J., Hernandez. T., 1987. The influence of organic materials on the physical and physico-chemical properties of soil. *Agriculture Mediterranean* 117: 309–318.

Soil Survey Staff., 2006. Keys to soil taxonomy. 10th ed. Washington DC, USA: US Government Printing Office.

SPSS 17.0, 2008. SPSS 17.0 for Windows. Chicago, IL, SPSS Inc.

Stamatiadis, S., Werner, M. , Buchanan, M., 1999. Field assessment of soil quality as affected by compost and fertilizer application in a broccoli field (San Benito County, California). *Applied Soil Ecology* 12: 217-225.

Tepecik, M., Esetlili, B.C., Cicekli, M., Cobanoglu, Ö., Öztürk, B., Anac, D., 2014. Effects of conventional and organic fertilizers on plant nutrition and essential oil components of basil. *Fresenius Environmental Bulletin* 23: 1159-1165.

Wang, J.Y., Stabnikova, O., Ivanov, V., Tay, S.T.L., Tay, J.H., 2003. Intensive aerobic bioconversion of sewage sludge and food waste into fertilizer. *Waste Management Research* 21: 405-415.