Acta Sci. Pol. Hortorum Cultus, 21(5) 2022, 15–23

https://czasopisma.up.lublin.pl/index.php/asphc ISSN 1644-0692 e-ISSN 2545-1405 https://doi.org/10.24326/asphc.2022.5.2

ORIGINAL PAPER

Accepted: 10.03.2022

EFFECTS OF HAZELNUT HUSK COMPOST AND TEA RESIDUE COMPOST ON QUALITY AND PERFORMANCE OF 5 BB AMERICAN GRAPEVINE ROOTSTOCK SAPLINGS

Hatice Bilir Ekbic[1]✉, Emre Yaman[1], Damla Bender Özenç[2], Ercan Ekbic[1]

[1]Faculty of Agriculture, Department of Horticulture, Ordu University, 52200, Ordu, Türkiye

[2]Department of Soil Science and Plant Nutrition, Faculty of Agriculture, Ordu University, 52200, Ordu, Türkiye

ABSTRACT

This study was conducted in unheated greenhouses and open-field nurseries of Ordu University Agricultural Faculty in 2017. Effects of hazelnut husk compost and tea residue compost on quality and performance of 5 BB American grapevine rootstock saplings were investigated. The 5 BB American vine rootstock saplings were used as the plant material and different media (soil, perlite, tea residue compost, hazelnut husk compost, soil + farmyard manure, soil + tea residue compost, soil + hazelnut husk compost, soil + tea residue compost + farmyard manure, soil + hazelnut husk compost + farmyard manure, soil + hazelnut husk compost + tea residue compost + farmyard manure) were used as the growing media. To determine the effects of experimental treatments, shoot growth parameters (shoot length, shoot diameter, number of leaves, leaf area, shoot dry weight), root growth parameters (root length, number of roots, root fresh and dry weight, root development level) and final sapling performance (1st grade sapling performance, 2nd grade sapling performance, total sapling performance) were determined. Tea residue compost was found to be effective on shoot and root growth parameters. Tea residue compost also yielded the greatest 1st grade (75%) and total sapling performance (90%). Soil + hazelnut husk compost + farmyard manure (79.6 cm^2) was prominent for leaf area and soil + tea residue compost + farmyard manure (28.1) was prominent for chlorophyll content. Soil + hazelnut husk compost + tea residue compost + farmyard manure (21.9 cm) was found to more effective only on root length.

Key words: hazelnut husk compost, tea residue compost, rootstock, viticulture

INTRODUCTION

Increasing population in the world made it necessary to make much more agricultural production, however, the wastes generated due to the increase in production have reached levels that are noteworthy. The damage caused by the waste materials in the environment required the most beneficial use of these wastes. Use of such high quantities of waste materials in agricultural practices will both prevent environmental pollution and provide great contributions as organic material in plant nutrition [Stella et al. 2020]. The majority of Turkey's agricultural land is known to be poor in organic matter. Organic materials are widely used to improve soil properties, such as improving the physical properties of the soil, water intake and aeration and to increase the plant nutrient content and indirectly productivity [Bender Ozenc and Ozenc 2008]. Plant harvest residues have recently been used widely in agricultural practices. Previous researches revealed that composted waste materials (hazelnut husk compost, tea residue compost, mushroom compost etc.)

✉ haticebilirekbic@gmail.com

CC BY

could be used alone or in combination with the other materials as growing media and source of nutrient and organic matter [Benito et al. 2005a,b, Cıtak et al. 2006, Ozenc et al. 2006]. Amount of organic matter supplied to soils with these waste materials vary based on plant species, growing conditions and climate parameters [Fageria 2012]. Increased demands and costs of peat and perlite commonly used as growing media in plant production directed growers to alternative high quality, but low-cost materials to be used as growing media. Since organic wastes could reduce environmental problems and utilized in a recyclable fashion, they can reliably be used as an alternative of peat. Eastern Black Sea Region of Turkey has a large potential for hazelnut husk and tea residues as organic waste and compost material [Ozenc et al. 2006]. Turkey with an annual production of 675 000 tons from 705 500 ha land area is the leading hazelnut producer of the world and with an annual production of 1 300 000 tons from 821 079 da land area is the fifth greatest tea producer of the world [Turkish Statistical Institute 2017]. Following the harvest, from 1 kg fresh hazelnut, 1/3 dry shelled hazelnut and 1/5 dry hazelnut husk is obtained. Harvested fresh tea leaves are processed into black tea in tea factories. Throughout such a conversion process, about 40 000 tons of tea waste is generated [Tutuş et al. 2015]. Hazelnut husk covering externally the hazelnut fruits turns from green into reddish brown or yellowish red at harvest season [Ozenc et al. 2006]. A small quantity of hazelnut husks is used as animal bedding material and the rest is either incinerated not to occupy a space or not used at all. Such unused quantities of postharvest residues generate various environmental problems for local growers and the region. Tea wastes should also be used properly since they generate storage problems and restrict factory spaces. It was reported that with appropriate composting, hazelnut husk might turn into material rich in organic matter and plant nutrients and have proper pH and salinity levels [Tutuş et al. 2015]. Tea wastes are quite rich in organic matter and macroelements (especially in nitrogen and potassium) [Khan et al. 2007]. Tea wastes have quite high water holding capacity and Vidyasagaran et al. [2014] reported the water holding capacity as 324%. American vine rootstocks in viticulture are generally used to prevent the damages caused by Phylloxera pest [Sucu and Yagcı 2017]. However, such a case has brought about some problems in viticulture practices [Kavak 2006]. Low quality and performance are major concerns in grafted and ungrafted vine sapling production. Considering the economic life of grower vineyards as about 40 years, the vine sapling need of Turkey is estimated to be 7.5–15 million [Sen and Yagcı 2016]. Varied with the years, the certified vine sapling production of Turkey was 4 349 560 in 2016 [Turkish Statistical Institute 2017]. In the production of vine saplings, environments such as peat, fermented farm manure, sand can be used at different rates. However, it was necessary to investigate whether the waste material left over from the tea and hazelnut plants grown intensively in the Black Sea Region in Turkey could be used after composting. This study was conducted to investigate potential use of some organic wastes as growing media and to determine the effects of different growing media on quality and performance of saplings of 5 BB American vine rootstock.

MATERIAL AND METHODS

Experiments were conducted in unheated plastic greenhouses and outdoor nursery spaces of Horticulture Department of Ordu University Agricultural Faculty in 2017. Dormant woody cuttings to be used in 5 BB American vine rootstock sapling production were supplied from Manisa Viticulture Research Institute in February. Cuttings were preserved in a cold storage at +4°C until the time of plantation. Before planting, cuttings were prepared as to have 3 buds. Two lower buds were blunted and planted into unheated perlite-filled planting trays on 8 March 2017. All planted cuttings rooted and completed a certain growth stage. Three months later, single-shoot rooted saplings were transplanted into 3-liter pots filled with *soil (S), *perlite (P), *tea residue compost (TRC), *hazelnut husk compost (HHC), *S + farmyard manure (FM; 1 : 1), *S + TRC (1 : 1), *S + HHC (1 : 1 : 1), *S + TRC + FM (1 : 1 : 1), *S + HHC + FM (1 : 1 : 1), *S + HHC + TRC + FM (1 : 1 : 1 : 1) media combinations on 15 June 2017. Chemical characteristics and some macro-micro elements of experimental growing media are provided in Table 1 and Table 2.

Sapling pots were taken out from the greenhouse and placed into outdoor nursery spaces with shadowed

Table 1. Chemical characteristics of experimental materials

Media	Texture	pH	EC (mmhos cm^{-1})	Organic matter (%)
S	clay	7.20	0.260	2.44
TRC	–	4.22	2.420	50.97
HHC	–	6.49	0.544	44.30
FM	–	8.50	5.430	47.63

S – soil; TRC – tea residue compost, HHC – hazelnut husk compost, FM – farmyard manure

Table 2. Macro and micro elements of experimental materials

Media	Microelements (mg kg^{-1})					Total N (%)	P (mg kg^{-1})	K (me 100 g^{-1})
	Zn	Fe	Cu	Mn	B			
S	0.12	9.20	0.28	4.68	0.73	0.09	9.63	5.50
TRC	66.11	1173.06	188.51	604.28	0.64	1.73	9.68	1.93
HHC	66.80	1288.81	136.94	572.33	0.59	0.98	8.25	4.33
FM	72.14	1336.86	105.73	850.66	0.81	1.20	8.11	7.62

S – soil; TRC – tea residue compost, HHC – hazelnut husk compost, FM – farmyard manure

conditions on 13 July 2017. Experiments were terminated on 18 September 2017. Saplings were regularly irrigated throughout the experiments. Shoot lengths (cm) of saplings grown in different media were measured with a ruler; shoot diameters (mm) were measured from the mid-section of the shoots with a caliper; number of leaves was counted; leaf areas (cm^2) were determined with the aid of a planimeter and leaf chlorophyll contents were determined with a SPAD meter. Shoots were dried in an oven at 65°C for 72 hours and weighed in a precision balance (±0.001 g) to get shoot dry weights (g).

Roots of saplings grown in different media were washed throughly. Root lengths (cm) were measured with a ruler; number of roots were counted; roots were dried in an oven at 65°C for 72 hours and weighed in a precision balance (±0.001 g) to get root dry weights. Root development levels were assessed based on the scale provided in [Celik 1982] (0: no rooting, 1: single-sided rooting, 2: two-sided rooting, 3: three-sided rooting and 4: all around rooting).

Potted Vine Sapling Standards (TS 3981) were taken into consideration to determine total sapling performance as 1st and 2nd grade sapling performance [Cangi et. al. 2017]. According to these standards, the saplings with at least 30 cm stem length, 7 mm stem diameter, 3 developed main roots and developed, lignified and at least 20 cm long shoot were classified as the 1st grade saplings and the saplings with at least 30 cm stem length, 5 mm stem diameter, 2 developed main roots and developed, lignified and at least 10 cm long shoot were considered as the 2nd grade saplings. Total sapling performance (%) was calculated as the total of the 1st and 2nd grade sapling performances.

Statistical analysis

Experiments were conducted in randomized plots design with 3 replications with 10 saplings in each. Experimental data were subjected to analysis of variance (ANOVA) with the use of JMP.10 statistical software and significant means were compared with the use of LSD test at 5% significance level.

RESULTS

Shoot and leaf development

Effects of different growing media on shoot and leaf development of 5 BB American vine rootstock sapling are provided in Table 3. Shoot and leaf development parameters were remarkably influenced by growing media and resultant differences were found to be significant.

The greatest shoot length was obtained from tea residue compost treatments (62.9 cm) and the lowest shoot lengths were obtained from soil (11.9 cm) and control (perlite) (13.8 cm) treatments. For shoot lengths, TRC treatment (62.9 cm) was followed by S + HHC + TRC + FM media (46.9 cm). HHC treatments provided higher shoot lengths than single perlite and soil treatments. The greatest shoot diameter (4.72 mm) was also obtained from TRC treatments and again as it was in shoot lengths, single HHC treatments yielded more effective shoot diameters than single perlite and soil treatments. HHC had distinctive effects on shoot diameter when combined with soil, tea residue compost and farmyard manure. HHC was also found to be more effective on shoot diameter when combined with soil as compared to single perlite and soil treatments. The greatest shoot dry weight (7.42 g) was obtained from TRC treatments and the lowest value (0.57 g) was obtained from S + FM treatments. TRC yielded greater shoot dry weights when combined with soil or FM as compared to single perlite and soil treatments. With regard to effects of HHC on shoot dry weights, it was observed that HHC was found to be more effective when combined with soil, TRC and FM.

The greatest number of leaves was obtained from TRC treatment with 32 leaves and the lowest number of leaves was obtained from S + FM treatment with 5 leaves. The greatest leaf area was observed in S + HHC + FM treatment (79.6 cm^2) and the lowest leaf areas were observed in HCC (21.7 cm^2), soil (23.4 cm^2) and perlite (24.7 cm^2) treatments. The S + HHC + FM combination was followed by single TRC treatment (69.2 cm^2). The S + HHC + TRC + FM (67.8 cm^2) and S + TRC + FM (66.3 cm^2) treatments were also placed into the same statistical group. Leaf areas of single hazelnut husk compost treatments were not significantly different from the leaf areas of single soil and perlite treatments. However, S + HHC combi-

Table 3. Effects of different growing media on shoot and leaf development parameters of 5 BB American grapevine rootstock saplings

Growing media	Shoot length (cm)	Shoot diameter (mm)	Shoot dry weight (g)	Number of leaves	Leaf area (cm^2)	Chlorophyll content (SPAD)
P	13.8 e	2.84 ef	1.07 de	6 de	24.7 e	10.8 f
S	11.9 e	2.91 def	1.19 de	7 de	23.4 e	8.8 f
HHC	18.8 de	3.14 def	0.97 de	6 de	21.7 e	16.7 e
TRC	62.9 a	4.72 a	7.42 a	32 a	69.2 b	15.4 e
S + FM	15.8 de	2.70 f	0.57 e	5 e	38.5 d	23.4 c
S + HHC	18.6 de	3.05 def	2.09 d	11 d	35.1 d	20.0 d
S + TRC	24.7 d	3.42 cde	3.67 c	18 c	47.5 c	21.0 d
S + HHC + FM	36.4 c	3.50 cd	4.04 c	17 c	79.6 a	26.2 ab
S + TRC + FM	41.7 bc	3.87 bc	4.19 c	17 c	66.3 b	28.1 a
S + HHC + TRC + FM	46.9 b	4.21 ab	5.55 b	24 b	67.8 b	25.4 bc
LSD (5%)	9.9	0.63	1.332	5	5.3	2.1

P – perlit; S – soil; HHC – hazelnut husk compost; TRC – tea residue compost, FM – farmyard manure. Mean values indicated by different letters identify significantly different groups ($P \leq 0.05$, LSD test) nation was found to be more effective than single perlite and soil treatments. S + FM combination was also more effective than single perlite and soil media. Chlorophyll contents (SPAD) were significantly influenced by growing media. The greatest chlorophyll content (28.1) was obtained from S + TRC + FM treatment and the lowest (8.8) in soil treatments. Since TRC or HHC treatments or S + HRC treatments were found to be more effective on chlorophyll contents than the single perlite and soil treatments. S + FM combination also had greater chlorophyll content (23.4) than the single perlite and soil media.

Root development

Effects of different growing media on root development parameters (root length, number of roots, root dry weight and root development levels) of 5 BB American vine rootstock saplings are provided in Table 4. Root development parameters were remarkably influenced by growing media and the differences were found to be significant.

The greatest root length (21.9 cm) was obtained from S + HHC + TRC + FM media and the lowest (4.9 cm) from S + TRC media. The S + HHC + TRC + FM media with the greatest root length was followed by TRC treatment with a root length of 18.3 cm. Rather than single use of HHC media (12.3 cm), S + HHC (13.5 cm), S + HHC + FM (16.9 cm) or S + HHC + TRC + FM (21.9 cm) combinations yielded greater root lengths. The greatest number of roots (30 roots) was obtained from TRC treatments and the least number of roots (6 roots) was obtained from S + FM media. For number of roots, TRC media was followed by S + TRC media with 20 roots. However, S + TRC + FM media yielded lower number of roots than single perlite and soil media. HHC media did not result in significant differences in number of roots as compared to perlite media, but was found to be more effective than single soil treatments.

As was found in number of roots, the greatest root dry weight (2.85 g) was obtained from TRC treatments and the lowest root dry weight (0.41 g) was obtained from S + FM treatments. The S + FM media with the least root dry weight was followed by soil (0.49 g) and perlite (0.71 g) treatments which were placed into the same statistical group. Single HHC treatments were found to be more effective than single perlite and soil treatments. However, for root dry weight, S+HHC or S + HHC + FM treatments were found to be more effective than single perlite and soil treatments. The greatest root development level (3.8) was obtained from TRC treatments and the lowest root development level (1.6) was obtained from S + FM followed by soil treatments (1.7).

Table 4. Effects of different growing media on root development parameters of 5 BB American grapevine rootstock saplings

Growing media	Root length (cm)	Number of roots (n)	Root dry weight (g)	Root development level (0-4)
P	12.3 cd	17bc	0.71d	3.3ab
S	7.6 ef	12d	0.49d	1.7d
HHC	12.3 cd	14cd	1.22cd	2.9bc
TRC	18.3 b	30a	2.85a	3.8a
S + FM	6.1 fg	6e	0.41d	1.6d
S + HHC	13.5 c	13d	2.68a	2.4c
S + TRC	4.9 g	20b	0.87cd	2.4c
S + HHC + FM	16.9 b	11d	2.16ab	2.4c
S + TRC + FM	10.1 de	11d	1.66bc	2.4c
S + HHC + TRC + FM	21.9 a	14cd	2.59a	2.9bc
LSD (5%)	2.6	3	0.917	0.6

Sapling performance parameters (%)

Effects of different growing media on the 1st and 2nd grade and total sapling performance on 5 BB American vine rootstock saplings are provided in Table 5. Both quality classes were remarkably influenced by growing media and differences were found to be significant.

The greatest 1st grade sapling performance (75.0%) was achieved in TRC media and the lowest (6.2%) was seen in S + FM media. TRC media was followed by S + HHC + TRC + FM media (50.8%). Rather than singe use of HHC or use of S + HHC and S + HHC + FM combinations, the S + HHC + TRC + FM treatments yielded greater 1st quality sapling performance (50.8%). The greatest 2nd grade sapling performance (60%) was obtained from soil treatments and the lowest (15%) in TRC treatments. Soil media were followed by HHC treatments with a 2nd grade sapling performance of 56.1%. Perlite media had 54.1% 2nd grade sapling performance. The greatest total sapling performance (90%) was achieved in perlite, TRC and soil media followed by HHC and S + HHC media. The lowest total sapling performance (51.1%) was observed in S + FM media.

DISCUSSION

When the shoot development parameters were assessed in general, it was observed that the best shoot development was achieved with TRC treatments and it was followed by S + HHC + TRC + FM media combination. S + TRC + FM media combination also exhibited a better shoot development just behind these two media. Since tea residue compost has high organic matter, N and P contents and low pH value, it might have improved availability of micronutrients and promoted plant nutrient uptake. Copper (Cu) exists in structure of several enzymes with a great role in vital metabolic processes, forms complexes with proteins, plays an important role in photosynthetic reactions and stimulates carbohydrate quantities during the vegetative growth stages of the plants. TRC is quite rich in Cu, thus such positive impacts of TRC on shoot development parameters could be attributed to high Cu

Table 5. Effects of different growing media on sampling performance of 5 BB American grapevine rootstock saplings

Growing media	1st grade sapling performance (%)	2nd grade sapling performance (%)	Total sapling performance (%)
P	35.9 bc	54.1 ab	90.0 a
S	30.0 bc	60.0 a	90.0 a
HHC	27.8 cd	56.1 ab	83.8 a
TRC	75.0 a	15.0 d	90.0 a
S + FM	6.2 d	49.1 abc	51.1 c
S + HHC	29.9 bc	50.9 ab	83.8 a
S + TRC	28.3 c	48.8 abc	63.9 bc
S + HHC + FM	28.1 c	39.1 bc	52.8 bc
S + TRC + FM	28.3 c	40.8 abc	55.1 bc
S + HHC + TRC + FM	50.8 b	28.8 cd	66.1 b
LSD (5%)	21.8	20.8	13.8

P – perlit; S – soil; HHC – hazelnut husk compost; TRC – tea residue compost, FM – farmyard manure. Mean values indicated by different letters identify significantly different groups (P ≤ 0.05, LSD test) contents. Rather than since use of HHC, combinations of HHC with soil, FM and TRC had greater positive effects on shoot development. Experimental materials were quite richer in organic material, N, P, Zn, Fe, Cu and Mn than the soil and perlite. Since sufficient Fe levels are directly related to plant Fe contents, chlorophyll synthesis and photosynthetic chain [Khobra 2014], such organic media might have influenced vegetative development and such a development then reflected in leaf development and chlorophyll contents. TRC with high organic matter content, besides high P contents, might have greater impacts on leaf growth and areas. Previous researchers also reported positive effects of organic substances supplemented into soils on plant shoot and leaf development [Seker and Ersoy 2005]. Some researchers also reported positive effects on TRC and HHC on plant heights of ornamental plants, corn and pepper [Kütük 2000, Yılmaz and Bender Ozenc 2012, Bender Ozenc and Hut 2018].

For root development in general, single TRC treatments was the most effective treatment and it was followed by S + HHC + TRC + FM media. There are several factors effecting root development, morphology and distribution including transfer of photosynthetic products into roots, plant nutrients, physicochemical characteristics of growing media [Kacar et al. 2009]. Experimental materials were organic substances, thus improved physical conditions of present clay soil. Roots exhibit better growth and development in well-aerated soils with proper moisture contents. Better outcomes of TRC media were attributed to greater transfer of photosynthetic products into roots. On the other hand, nitrogen has the greatest effects on root development, and it was followed by phosphorus. Nitrogen increases root surface area and length, thus increases root contact with soil, then promotes water and nutrient uptake of the roots from the soil. Since TRC is quite rich in nitrogen and phosphorus, the best root development was achieved in media containing TRC. Koc [2008] reported significant effects of organic fertilizers supplemented into soils on root development levels. Flores [2014] investigated the effects farmyard manure, vermicompost and vermicompost tea on root growth and development of grapevines and reported 15% longer root development in farmyard manure and vermicompost tea treatments. Bender Ozenc and Ozenc [2007] used hazelnut husk compost as growing media under greenhouse conditions and indicated that organic matter influenced root length and surface area. Yılmaz and Bender Ozenc [2012] indicated regular effects of tea residue and hazelnut husk compost on total root length of maize and reported the greatest root length for 8% dose of tea residue compost. Akın [2009] worked with sand, farmyard manure and forest soil and reported significant effects of growing media on root fresh and dry weights. Kutuk [2000] indicated that tea residue could be supplemented into growing media at certain doses to improve root growth and development. Bender Ozenc and Hut [2018] reported positive effects of tea residue compost on root development of pepper plants.

Considering the primary target of producing the 1st grade saplings, TRC and S + HHC + TRC + FM media were found to be more effective in the 1st grade sapling performance. Previous researchers also reported positive effects of organic matter supplementations into soils on plant growth and development [Polat and Almaca 2006, Bender Ozenc and Hut 2018]. Experimental soil has clay texture and quite poorer in organic matter than TRC, HHC and FM media. Thus, TRC and HHC yielded distinctive differences in this sense. The pH and electrical conductivity values of TRC were also within sufficient ranges. In brief, because of quite high organic matter contents, TRC and HHC yielded remarkable differences in sapling quality and performance. Positive effects of TRC and HHC supplementations into growing media on sapling development were also supported by the findings of earlier studies.

CONCLUSION

It was concluded based on present findings that TRC and HHC had positive effects on vine sapling quality and performance. TRC was found to be prominent with greater impacts on both shoot and root development and sapling performance. Rather than single use, combined use of HHC was found to be more effective on sapling development. Besides, S + HHC + TRC + FM media could also be recommended for better development and performance of 5 BB American vine rootstock saplings. Black Sea Region of Turkey has quite available conditions for tea and hazelnut culture and plenty of waste materials of these products are available in the region. Potential use of these organic wastes in cultural practices and sapling production may provide significant economic contributions to growers and producers without environmental demages.

SOURCE OF FUNDING

This research has been funded by ODUBAP under grant (project code: by-1737).

REFERENCES

Akın, E. (2009). Effects of different growing media on seedling quality of caper (*Capparis ovata* Desf.). Msc Thesis, Artvin Coruh University, Institute of Science, Artvin, 45 p. [in Turkish].

Turkish Statistical Institute. (2017). Agricultural statistics. Crop Production Statistics Database. Available: www.FÜAB.org.tr.

Bender Ozenc, D., Hut, D. (2018). Effects of tea litter compost and salt applications on the growth of pepper plant. Toprak Bilimi ve Bitki Besleme Dergisi 6(2), 86–94 [in Turkish].

Bender Ozenc, D., Ozenc, N. (2008). Short-term effects of hazelnut husk compost and organic amandment applications on clay loam soil. Compost Sci. Util., 16(3), 192–199.

Bender Ozenc, D., Ozenc, N. (2007). The effect of hazelnut husk compost and some organic and inorganic media on root growth of kiwifruit (*Actinidia deliciosa*). J. Agric., 6(1), 113–118.

Benito, M., Masaguer, A., De Antonio, R., Moliner, A. (2005a). Use of pruning waste compost as a component in soilless growing media. Biores. Technol., 96, 597–603.

Benito, M., Masaguer, A., Moliner, A., De Antonio, R. (2005b). Chemical and physical properties of pruning waste compost and their seasonal variability. Biores. Technol., 97(16), 2071–2076.

Celik, H. (1982). The effects of different rooting media and NAA applications on the production of grafted rooted saplings under greenhouse conditions for Kalecik Karası/41 B grafting combination. Assoc. Thesis, Ankara Üniversitesi, Ziraat Fakültesi, 73, Ankara [in Turkish].

Cangi, R., Doğan, A., Yağcı, A., Uyak, C. (2017). Developments in the production of certified vine saplings in our country Asma Fidanı Üretim Tekniği, 86 s. [in Turkish].

Cıtak, S., Sonmez, S., Okturen, F. (2006). The usage possibility of plant origin wastes in agriculture. Derim, Batı Akdeniz Tarımsal Araştırma Enstitüsü, 23(1), 40–53 [in Turkish].

Fageria, N.K. (2012). Role of soil organic matter in maintaining sustainability of cropping systems. Commun. Soil Sci. Plant Anal., 43, 2063–2113. http://doi.org/10.1080/00103624.2012.697234

Flores, K.M. (2014). Root stimulation using vermiproducts in grapevine propagations. Wine and Viticulture Department, Viticulture concentration, California Polytechnic State University, San Luis Obispo (CPSU, SLO) http://digitalcommons.calpoly.edu/wvisp/2/- [date of access: 08.05.2018].

Kacar, B., Katkat, A.V., Ozturk, S. (2009). Plant Physiology. Nobel Bilim ve Araştırma Merkezi, Yayın No: 46, Ankara, 545 s. [in Turkish].

Kavak, O. (2006). The effects of mychorriza and humic acid applications on quality of grafted and potted plant propagation in grapes. Selcuk University, Institute of Science, MSc Thesis, 52 p. Konya [in Turkish].

Khan, M.A.I., Ueno, K., Horimoto, S., Komai, F., Tanakal, K., Ono, Y. (2007). Evaluation of the physio-chemical and microbial properties of green tea waste-rice bran compost and the effect of the compost on spinach production. Plant Prod. Sci., 10(4), 391–399.

Khobra, R., Ahuja, S., Singh, B. (2014). Chlorophyll biosynthesis as the basis of iron use efficiency under iron deficiency and its relationshipwith the phytosiderophore synthesis and release in wheat. Ind. J. Plant Physiol. 19, 330–337. https://doi.org/10.1007/s40502-014-0112-9

Koc, F. (2008). Effects of different organic fertilizers on growth and nutrition of tomato and pepper plants. Msc Thesis, Ankara University, Institute of Science, Soil Science Department, Ankara, 175 p. [in Turkish].

Kutuk, C. (2000). Growing media of tea waste compost and waste mushroom compost use in ornamental plant cultivation as a component. Mustafa Kemal Üniversitesi Ziraat Fakültesi Dergisi, 5(1–2), 75–86 [in Turkish].

Ozenc, N., Ozenc, D.B., Caycı, G. (2006). Effects of hazelnut husk compost, peat, farmyard, and chicken manure on soil organic matter and N nutrition and hazelnut yield. 18th International Soil Meeting (ISM) on Soil Sustaining Life on Earth, Managing Soil and Technology, 22–26 May, Sanlıurfa, Turkey. Proceedings. Vol 2. 937–945.

Polat, H., Almaca, N.D. (2006). The effect of compost and green manure application on soil properties and cotton yield on the leveled lands in the Harran plain. Toprak ve Su Kaynakları Araştırma Enstitüsü Yayınları, Sanlıurfa [in Turkish].

Stella, M.A., Olanrewaju, S., Babalola, O.O., Odeyemi, O. (2020). Waste management through composting: challenges and potentials sustainability, 12(4456), 1–23. https://doi.org/10.3390/su12114456

Sucu, S., Yagcı, A. (2017). Determination of sapling yield and quality features in some rootstocks and Sultanı Çekırdeksız (*Vitis Vinifera* L.) variety grafted on these rootstocks. Ege Üniv. Ziraat Fak. Dergisi, 54 (1), 53–59 [in Turkish].

Seker, C., Ersoy, I. (2005). Effects of different organic manures and leonardite on soil properties and growing of maize plant (*Zea mays* L.). Selçuk Üniversitesi Ziraat Fakültesi Dergisi, 19(35), 46–50.

Sen, A., Yagcı, A. (2016). Effects of different rooting places on seedling quality and efficiency in production of potted grapevine saplings. Meyvecilik Araştırma Enstitüsü Müdürlüğü, 22–28 [in Turkish].

Tutus, A., Kazaskeroğlu, Y., Cicekler, M. (2015). Evaluation of tea wastes in usage pulp and paper production. BioResources, 10(3), 5407–5416.

Vidyasagaran, K., Kumar, V., Ajeesh, R. (2014). Utilization of municipal garbage as component potting media for the production of teak (*Tectona grandis* L.f) seedlings in the nursery. Ecoscan, 8(3–4), 215–219.

Yılmaz, S., Bender Özenç, D. (2012). Effects of hazelnut husk compost and tea waste compost on growth of corn plant (*Zea mays* L.)". 8th International Soil Science Congress on "Land Degradation and Challenges in Sustainable Soil Management", 15–17 May, Ceşme, Izmir, Turkey, 620–626 p.