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ARAŞTIRMA MAKALESİ **RESEARCH ARTICLE**

Effects of Vermicompost Applications on Microelemental Contents of Olive Saplings' Production Material

Vermikompost Uygulamasının Zeytin Fidanlarının Üretim Materyalindeki Mikro Element İçerikleri Üzerine Etkisi

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Abstract

Disseminations of organic fertilizer use in olive sapling nursery is very important. When the saplings are developed well at the beginning, this will be important for root development after planting to land, decreasing the future yield lowness, and even obtaining large amount of high quality olive grain and oil, therefore studies about this subject are essential. In this study, Gemlik olive (*Olea europaea* L. cv. Gemlik) variety saplings were grown with applications of different doses of the vermicompost that is an organic fertilizer (0, 5, 10, 20 and 40%) to production material and single dose of chemical fertilizer which is used commonly by planters (100% production material + chemical fertilizer). The micro nutrients content of the production material were analyzed. According to the results, the micro nutrients analysis of the production material used for the growth of olive saplings at the 3rd and 6th months was significant. Fe, Cu, Mn, Zn and B values as the average of all treatments were 12309.56, 34.74, 625.66, 52.61 30.85 at the 3rd month and 12066.24, 28.60, 507.03, 47.40, 29.98 mg kg^{-1} at the 6th month. In general, 40% vermicompost (VC) + 60% production material (PM) increased the micro elemental content. Use of vermicompost in production material can be said to increase quality of production material and positively affect nourishment of olive saplings and their developments. Vermicomposting is a simple biotechnological process of composting, in which certain species of earthworms (*Eisenia foetida* etc.) are used to enhance the process of waste conversion and produce a better product. The use of vermicompost is important for the sustainability of agriculture. These results showed that the effects of different organic material (vermicompost) applications on olive sapling properties are important.

Keywords: Olive sapling, Vermicompost, Production material, Micro nutrients

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Özet

Zeytin fidanı yetiştiriciliğinde, organik gübrelerin kullanılmasının yaygınlaştırılması son derece önemlidir. Fidanlar başlangıçta sağlıklı olarak yetiştirildiğinde, araziye dikim sonrası oluşacak kök gelişimleri, ileride yaşanabilecek verim düşüklüklerinin azaltılması açısından ve hatta yüksek ve kaliteli zeytin dane ve yağının elde edilmesine yol açabileceğinden "zeytinde organik gübreleme" ile ilgili çalışmaların önem kazanmaya başladığı görülmektedir. Bu çalışmada zeytin (*Olea europaea* L. cv. Gemlik) fidanı yetiştiriciliğinde kullanılan üretim materyaline organik gübre olarak vermikompostun farklı dozları (%0, 5, 10, 20, 40) ve üreticiler tarafından yaygın olarak kullanılan kimyasal gübre tek dozda (%100 üretim materyali + kimyasal gübre) kullanılarak Gemlik çeşidi zeytin fidanları yetiştirilmiştir. Fidanların yetiştirildiği üretim materyalinin mikro element içerikleri analiz edilerek incelenmiştir. Araştırma sonuçlarına göre, zeytin fidanlarının yetiştirildiği üretim materyallerinin denemedeki 3. ve 6. ay yapılan mikro besin elementi analiz sonuçları istatistiki olarak önemli bulunmuştur. Denemenin 3. ayında Fe, Cu, Mn, Zn ve B değerleri tüm uygulamaların ortalaması olarak sırasıyla 12309.56, 34.74, 625.66, 52.61, 30.85; 6. ayda ise 12066.24, 28.60, 507.03, 47.40 ve 29.98 mg kg^{-1} olarak bulunmuştur. Genel olarak %40 VK (vermikompost) + %60 ÜM (üretim materyali) uygulamasının üretim materyalinin mikro besin elementleri içeriğini arttırdığı belirlenmiştir. Vermikompostun üretim materyali içerisinde kullanılmasının gerek üretim materyalinin kalitesine gerekse fidanların beslenmesine ve gelişimine oldukça olumlu katkılar sağlayabileceği söylenebilir. Vermikompost üretimi, atık dönüşüm sürecini geliştirmek ve daha iyi bir ürün üretmek için bazı solucan türlerinin (örneğin *Eisenia foetida* gibi türler) kullanıldığı basit bir biyo-teknolojik kompostlama sürecidir. Vermikompostun kullanımı sürdürülebilir tarım için oldukça önemlidir. Bu sonuçlar, farklı organik materyal (vermikompost) uygulamalarının zeytin fidanı özellikleri üzerine etkilerinin önemli olduğunu sonucunu ortaya koymuştur.

Anahtar Kelimeler: Zeytin fidanı, Vermikompost, Üretim materyali, Mikro besin elementleri

1. Introduction

Olive cultivation is an important agricultural activity in the world and in our country. The growth of olive nursery is increasingly popular agricultural activity in our country in recent years. However, there is no enough available source for the use of the most appropriate fertilizer (generally organic fertilizer) in the cultivation of olive nursery. Growing olive saplings is a situation that requires important information. Producers do this work generally by using chemical fertilizers. The most commonly used chemical fertilizers are 20-20-0, 15-15-15 and 18-46-0 (DAP) composed fertilizers. Some producers also use cow manure to produce olive saplings. However, such organic fertilizers may also cause problems if not properly prepared. Therefore, there is a lack of information about what should be the most suitable organic fertilizer. In this study, it is planned to use worm manure (vermicompost) which is considered suitable for olive seedling production. However, this study was planned because there is not enough information about which dose of vermicompost should be used. In this study, the chemical fertilizer which is commonly used by the farmers as a chemical fertilizer (100% production material + chemical fertilizer) and the organic fertilizer which is used in different doses (0%, 5%, 10%, 20% and 40% vermicompost) as vermicompost are used for the production of olive sapling. Young plants of olive cultivar Gemlik (*Olea europaea* L. cv. Gemlik) were grown using 36 pots, totally 6 applications, 3 replications and 2 periods (Period A: 3rd month, Period B: 6th month). The experiment lasted 6 months and has been carried out in 2-stage, 3-month, in the laboratory with controlled conditions. At the end of the third and sixth months of the experiment, some micro nutrients (Fe, Mn, Zn, Cu, B) analyzes were made in the plant samples and potted production materials. In the direction of the project results, we can say that vermicompost can be used easily in production material in growing olive sapling. According to the results, the highest contents of all the micro nutrients were obtained from 40% VC (vermicompost) + 60% PM (production material) after the 6th month of the trial. If the V is to be used in olive sapling cultivation, it will be beneficial for the producers to consider this situation. This study also includes information that will help in the preparation of PM that should be used in olive sapling production.

Olive is a plant with increasing importance as a factor in healthy human nutrition and as flavor at the table. According to TUIK (2018), data the area of olive orchard in Turkey is 864,428 ha and total olive trees are 177,843,966. Among these trees, 126,874,171 of them are for oil production, 50,969,795 are grown to be table olive. Fertilization studies for olive orchards become more important in recent years. Although, especially the young saplings, give yield every year, major changes have been observed in olive tree development in olive orchards due to global climate changes. Besides, yield differences between the trees became very frequent. Therefore, in order to decrease the yield lowness and maintaining the healthy development of trees, the need for the condensation of studies about fertilization of olive plants appeared. Moreover, dissemination of organic fertilizer use for olive plants is important as well. When the saplings are developed well at the beginning, this will be important for root development after planting to land, decreasing the future yield lowness, and even obtaining large amount of high-quality olive grain and olive oil, therefore studies about this subject are essential.

Vermicompost is produced by the digestion of organic material by worms and it is a material that has many positive effects on plant development, soil amelioration, plant health and environment (Fritz et al., 2012; Bellitürk et al., 2013 and 2015; Göçmez et al., 2019). According to the results of a recent study, some plants grown by vermicompost applications play important roles in remediation of heavy metals from the soil (Bellitürk et al., 2015; Shrestha et al., 2019).

In this study, Gemlik olive variety saplings were grown for 6 months with different amounts of vermicompost added to the production material commonly used for olive nursery. Micro elemental content analyses of the production material were carried out at the 3rd and 6th months of the study.

2. Materials and Methods

This study was carried out in controlled laboratory conditions for 6 months. Saplings of Gemlik olive variety were grown; chemical fertilizer and vermicompost were applied to production material of these saplings.

The treatments to the pots on which olive saplings were grown were as follows: **1-** Production material (1/3 soil + 1/3 peat + 1/3 sand as a volume), **2-** 100% production material + chemical fertilizer (15-15-15), **3-** 5% vermicompost

+ 95% production material, **4-** 10% vermicompost + 90% production material, **5-** 20% vermicompost + 80% production material, 6- 40% vermicompost + 60% production material. Micro elemental analyses of the peat and the soil used in production material used in the pots were carried out (Table 1). Olive saplings were harvested at the 3rd and 6th months of the trial and micro nutrients content analyses of the corresponding periods were done.

The micro nutrients contents (iron, cupper, manganese, zinc and boron) analyses of the soil and the peat in the production material were carried out with ICP-OES using the filtrate obtained from microwave burning with H_2O_2 + HNO_3 (Zarcinas et al., 1987). The iron, cupper, manganese and zinc analyses of the soil used in the production material were done with ICP-OES using the filtrate obtained by extracting the samples by DTPA (pH 7.3) (Lindsay and Norvell, 1978). Boron analysis was done with ICP-OES after extracting the samples with 0.01 M mannitol + 0.01 M calcium chloride (Kacar and Fox, 1966). The study contained 6 treatments x 3 replicates x 2 periods = 36 olive sapling. The statistical analyses of the results were carried out by SPSS 11.0 software (SPSS, 2009).

Table 1. Microelement Analysis Results of Soil, Vermicompost and Peat Used in the Production Material

Parameters	Unit	Soil	Peat	Vermicompost
Fe	mg kg^{-1}	10.62	2558.03	8416.43
Cu	mg kg^{-1}	1.05	20.73	499.17
Mn	mg kg^{-1}	10.33	54.35	380.39
Zn	mg kg^{-1}	0.58	25.07	379.95
B	mg kg^{-1}	0.55	11.59	75.75

3. Results and Discussion

The micro nutrients analysis results of the production material after the 3rd month are given in Table 2.

Table2. The Analysis Results of Micro Nutrient Contents of the Production Material at the End of 3rd Month

Applications	Fe (mg kg^{-1})	Cu (mg kg^{-1})	Mn (mg kg^{-1})	Zn (mg kg^{-1})	B (mg kg^{-1})
100 % PM	12338.45	13.52	576.24	31.87	30.15
100 % PM	12411.10	14.70	575.77	34.70	29.78
100 % PM	12544.24	12.18	572.31	33.40	28.68
100 % PM+ CF	12630.00	14.68	607.71	41.53	30.11
100 % PM+ CF	12548.37	13.99	602.85	40.89	30.20
100 % PM+ CF	12684.59	14.69	607.38	40.38	30.14
5% VC+ 95%PM	11928.09	42.48	615.25	44.25	29.00
5% VC+ 95%PM	11648.04	42.33	619.02	43.38	28.12
5% VC+ 95% PM	11287.37	41.56	617.79	44.19	27.76
10% VC+90% PM	12154.78	39.55	635.99	53.35	28.73
10% VC+90% PM	12286.34	37.71	633.02	51.78	28.14
10% VC+90% PM	12102.75	40.89	636.27	52.65	28.81
20% VC+80% PM	12276.58	42.29	655.00	65.52	30.05
20% VC+80% PM	12734.72	46.79	654.18	65.39	31.94
20% VC+80% PM	12269.34	44.57	654.13	66.01	32.38
40% VC+60% PM	12233.63	54.00	663.18	78.87	37.57
40% VC+60% PM	12615.11	53.67	669.08	79.84	36.83
40% VC+60% PM	12878.61	55.69	666.72	79.02	36.89

The lowest Fe was found in 5% VC + 95% PM, and the highest in40% VC + 60% PM; the lowest Cu was determined in 100% PM while the highest was in 40% VC + 60% PM; the lowest Mn was found in 100% PM, the highest Mn was in 40% VC + 60% PM; the lowest Zn content was obtained from 100% PM and the highest Zn was obtained from 40% VC + 60% PM; the lowest B was in 5% VC + 95% PM, the highest B was in 40% VC + 60% PM (Table 2).

The highest contents of all the micro nutrients were obtained from 40% VC + 60% PM after the 6th month of the trial. This shows that addition of vermicompost into the production material increases the micro nutrient contents and therefore the plants can benefit more from these elements.

The micro nutrients analysis results of the production material after the 6th month are given in Table 3.

Table 3. The Analysis Results of Micro Nutrient Contents of the Production Material at the End of 6th Month

Applications	Fe (mg kg^{-1})	Cu (mg kg^{-1})	Mn (mg kg^{-1})	Zn (mg kg^{-1})	B (mg kg^{-1})
100% PM	11356.35	12.24	466.32	31.24	27.32
100% PM	11335.65	13.64	468.95	32.58	27.87
100% PM	11359.22	12.65	462.31	33.65	28.12
100% PM+CF	11854.32	13.65	489.95	35.85	29.21
100% PM+CF	11882.21	14.54	481.32	36.74	29.65
100% PM+CF	11887.39	14.89	485.28	36.87	29.51
5% VC+95% PM	11155.62	20.21	499.95	39.34	28.85
5% VC+95% PM	11146.32	20.22	495.65	40.12	27.45
5% VC+95% PM	11151.84	20.20	497.51	40.55	27.21
10 % VC+90% PM	12556.32	25.25	501.25	41.55	28.15
10% VC+ 90% PM	12587.21	26.54	502.68	41.87	28.52
10% VC+ 90% PM	12536.65	26.87	509.87	42.98	27.51
20% VC+ 80% PM	12654.32	41.70	525.68	60.75	30.05
20% VC+ 80% PM	12687.25	41.35	532.65	61.82	30.66
20% VC+ 80% PM	12697.84	42.58	528.97	61.55	30.94
40% VC+ 60% PM	12789.65	55.66	555.87	71.51	36.21
40% VC+ 60% PM	12798.54	56.98	564.87	72.46	36.71
40% VC+ 60% PM	12755.61	55.64	557.52	71.81	35.73

The lowest Fe content was obtained from 5% VC + 95% PM and the highest from 40% VC + 60% PM, the lowest Cu content was found in 100% PM and the highest in40% VC+ 60% PM, the lowest Mn content was in 100% PM and the highest M content was in 40% VC + 60% PM, the lowest Zn content determined in 100% PM and the highest in 40% VC + 60% PM and finally the lowest B content was found in 5% VC + 95% PM and the highest B content was obtained from 40% VC + 60% PM. The highest content of all elements at the end of 6th month were obtained by the treatment of 40% VC + 60% PM similar to 3rd month results. This situation again shows that enriching the production medium with vermicompost increases the micro nutrients contents of the medium in which olive saplings were grown. Hence, the plants can benefit more from the micro nutrients they require.

The micro nutrient analysis results of the production materials after 3rd and 6th months are given in Table 4.

Table 4. Statistical Analysis Results of the Micro Nutrient Contents of Production Material at the End of 3rd and 6th Months

Applications	Fe (mg kg^{-1})	Cu (mg kg^{-1})	Mn (mg kg^{-1})	Zn (mg kg^{-1})	B (mg kg^{-1})
3rd Month					
100% PM	12431.26 ab	13.46 e	574.77 f	33.32 f	29.53 cd
100% PM+CF	12620.98 a	13.45 e	605.98 e	40.93 e	30.15 c
%5 VC+%95 PM	11621.16 c	39.38 d	617.35 d	43.94 d	28.29 d
%10 VC+%90 PM	12181.29 b	42.12 c	635.09 c	52.59 c	28.56 d
%20 VC+%80 PM	12426.88 ab	44.55 b	654.43 b	65.64 b	31.45 b
%40 VC+%60 PM	12575.78 ab	54.45 a	666.32 a	79.24 a	37.09 a
6th Month					
100% PM	11350.40 e	12.84 f	465.86 e	32.49 f	27.77 d
100% PM+CF	11874.64 d	14.36 e	485.51 d	36.48 e	29.45 c
5% VC+ 95% PM	11151.26 f	20.21 d	497.70 c	40.00 d	27.83 d
10%VC+ 90% PM	12560.06 c	26.22 c	504.60 c	42.13 c	28.06 d
20% VC+80% PM	12679.80 b	41.87 b	529.10 b	61.37 b	30.55 b
40% VC+ 60% PM	12781.26 a	56.09 a	559.42 a	71.92 a	36.21 a

The highest Fe content was observed at 100% PM, 100% PM + CF, 20% VC + 80% PM and 40% VC + 60% PM (Table 3) . The highest Cu, Mn, Zn and B contents were obtained from 40% VC + 60% PM for both 3rd and 6th month. Ramnarain et al. (2019) revealed that vermicompost is rich in plant micro nutrients. Barlas et al. (2018) expressed that vermicompost was an important nutritional source for their study on wheat. Alidadi et al. (2014) stated a similar result for their study on tomato plant as vermicompost was a potential nutrients source. Sönmez and Özen (2019) showed that increased amounts of vermicompost applications increased the available Zn and Mn contents in the experiment soils.

4. Conclusions

There have been many studies on the contents of production materials used for olive sapling production. The contents of production materials are important in terms of plant development. Vermicompost, when considered alone, is more than an organic fertilizer, it is a good soil ameliorator and an environmental and economical material that makes culture plants resistant to diseases (Bellitürk, 2016). The use of such organic fertilizers for important culture plants like olive has many advantages. Therefore, addition of vermicompost to production material of olive sapling is considered to be advantageous for both the quality of the production material and plant development. The results of this study revealed that vermicompost application to olive saplings' production materials a positive implementation for the uptake of microelements by the plants. The results obtained from the study answer the various questions of olive saplings producers. It is also important to note that the use of organic fertilizers, especially in production materials, gives favorable results compared to those used only chemical fertilizers. Adding organic fertilizers to the production material is also important for plant health and quality. Further studies are needed on this subject. This study contains results that can guide future studies especially micro nutrients.

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