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The Effects of Malch Applications on the Seedling Quality of 110R and Fercal Grape Rootstocks*

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ABSTRACT

Viticulture, in Turkey as well as all over the world is one of the most important agricultural activities as socio-economic issues. Significant quantities of high-quality grapevine seedlings are needed to maintain and improve the current state of viticulture at national and global levels. Soil cultivation, irrigation and plant protection activities in the sapling production process not only increase the production cost, but also affect the yield and quality of the seedlings. In this study, mulch applications (Black plastic BP, Black plastic jute PJ, Biodegradable plastic BD, Wheat stalk OM and Control) of 110R and Fercal grape rootstocks obtained from the Sub-Union of Sapling Producers, from standard graftable quality virus free cuttings, in open area conditions was done. Effects of applications on seedling yield and quality (soil temperature (°C), leaf temperature (°C), stomatal conductivity (mmol m^{-2} s^{-1}), leaf chlorophyll content (spad value), leaf area (cm2), leaf number (pieces), leaf weight (g), shoot length (cm), shoot diameter (mm), pruning residue weight (g), shoot development level (0-4 scale), root numbers (pieces) and diameter (mm), root fresh and dry weight (g), root growth level (0-4 scale) and seedling efficiency (%) were examined. While mulch applications in general provided improvement in all parameters examined, the efficiency varied according to grapevine rootstocks and examined properties. In terms of seedling efficiency, BP application in Fercal rootstock and BD application in 110R rootstock were most effective. According to the data obtained from this study, the positive effects of BP and BB, PJ and OM mulch applications were determined in the production of grape rootstock seedlings in open areas and especially in areas where the relative humidity was very low.

1. Introduction

Viticulture, in Turkey as well as all over the world is one of the most important agricultural activities as socio-economic issues. Turkey is 416 907 ha of vineyards and grape production by 4.2 million tons, the world's 5th largest grape producer countries (Faostat 2020). Since the phyloxerae (*Daktulospharia vitifoliae* Fitch) moved from America to Europe at the end of the 19th century, seedling production, seedling yield and quality of grapevine rootstocks is one of the primary issues in the viticulture industry.

Traditional agricultural practices can affect the efficiency and durability of soil and environmental ecosystems, leading to soil degradation. Some common practices in traditional viticulture, such as the continuous use of herbicides, may lead to increased soil quality and overall sustainability losses of the grape production system (Ingels 1992). In order to use water resources more efficiently, water saving methods have become mandatory (Kanber et al. 1991).

Mulching is a protective layer consisting of organic or inorganic materials applied on the soil to create a suitable environment for the soil surface, plant growth, development and efficient production around the plant (Bakshi et al. 2015). Viticulture experts want to protect a healthy and productive soil. Depending on the situation, mulch may be an appropriate option (Ross 2010).

Mulches affects soil temperature, moisture level, nutrition level, microorganism activity (Ross 2010; Mundy and Agnew 2002), suppresses weeds, and provides advantages by increasing seedling yield and quality in nurseries (Nauleau 1997; Wheeler et al. 2005; Nazrala 2008; Bakshi et al. 2015; Watson 2006; Chan et al. 2010; Arslan and Uygur 2014; Cowan 2013; Król-Dyrek and Siwek 2015; Zengin 2019; Dağ 2017;

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Küçükyumuk 2009; Zenginoğlu 2015; Zhang et al. 2014; Ferrara et al. 2012; Hostetler et al. 2007).

In this study, the effects of OM, BD, BP and PJ mulch applications used to improve seedling yield and quality in sapling production parcels created by direct planting of Fercal and 110R grape rootstocks for the production of rooted grapevine seedlings in open area conditions were examined.

2. Material ve Metot

OM (Wheat stalk): The wheat stalk in the bale form was laid in rows in the sapling production plot just before planting 80 mm wide and 10 cm thick vine rootstock cuttings.

BP and PJ as inorganic malches were produced by Filesan İskenderun TR company for use as agricultural mulch, and they were laid at the 80 cm width of the sapling production parcel rows, 80 cm wide, just before planting of the rootstocks.

Biodegradable mulch (BD): The product, which was produced and introduced to the market for agricultural use through the Ankara Agricultural Market TR company, was laid just before planting 80 cm wide vine rootstock cuttings in the rows of seedlings production plots.

Control: It was a sapling production plot created directly under the influence of environmental extracts without applying any mulch.

Fercal [(*Vitis vinifera* L. × *Vitis berlanderi* L.) × 333 EM] and *110R* **(**Berlandieri Resseguier No: 2 × Rupestris Martin) were used as roorstock cuttings. Both of them are supplied as standard rootstock cuttings (TS 3981, TS 3912) from the Sapling Produrers Sub-Association. Trial 3 repetitive random blocks were established according to the trial pattern and the number of cuttings in the parcel was 30.

Following the soil preparation, which was initiated in autumn and repeated in early spring, cutting were planted for the trial in early April as 15 cm x 80 cm between cuttings, routine cultural practices was carried out in the summer period, records were kept and post-harvest measurements were carried out by harvesting rooted saplings in autumn (in November).

The trial plots soil temperatures (°C), leaf temperature (° C, by SC-I Leaf Porometer), stomatal conductivity (mmol m^{-2} s^{-1}, by SC-I Leaf Porometer), leaf chlorophyll content [(spad value by Minolta Spad Meter 520,(Kara et al. 2017)], leaf area (cm^2), leaf number (pieces), leaf weight (g), shoot length (cm), shoot diameter (mm), pruning residue weight (g), shoot development level (0-4 scale), number of roots (pieces) and root diameter (mm), root fresh and dry weight (g), root growth level (0-4 scale) and seedling efficiency (first and second grade %) were examined.

Statistical analyses

A complete randomized block design with three replicates and 30 cuttings sample in each replicate for mulch applications, for both grape rootstcks were established. The numerical data obtained were compared with Student's t-test at 0.05 significance level using SPSS 17.0 and JMP 7 statistical programs.

3. Results and Discussion

Stomatal conductivity (mmol m^{-2} s^{-1})

Mulch applications on stomatal conductivity were significant ($p < 0.05$) (Figure 1). Generally, the values obtained from 110R were higher than Fercal, but when the measurement times and applications were evaluated together, there was no stable situation in both rootstocks. On 30 July, the highest stomatal conductivity was recorded as 261.86 mmol m^{-2} s^{-1} in Fercal control and 296.33 mmol m^{-2} s^{-1} in BD application in 110 R. On August 20, the highest values [(Fercal 316.80 mmol m^{-2} s^{-1}, 110R 331.73 mmol m^{-2} s^{-1})] were detected in BP application, on August 10, the maximum values were detected in Fercal control as 313.30 mmol m^{-2} s^{-1} and in 110R PJ application as 347.27 mmol m^{-2} s^{-1}. On August 20, the highest values were detected in [(Fercal 316.80 mmol m^{-2} s^{-1}, 110R 331.73 mmol m^{-2} s^{-1})] BP aplication. On September 10, the highest values were 31.30 mmol m^{-2} s^{-1} in Fercal control and 347.27 mmol m^{-2} s^{-1} in 110R PJ aplication. On September 1, the maximum values were determined in BD application in Fercal (265.53 mmol m^{-2} s^{-1}) and PJ applications in 110R (368.63 mmol m^{-2} s^{-1}). In a similar study, Zengin (2019), 99 R, 44-53 M, Rupestris du Lot and 41B grape rootstock seedlings did not show a stable situation in the effect of mulch applications on stomatal conductivity.

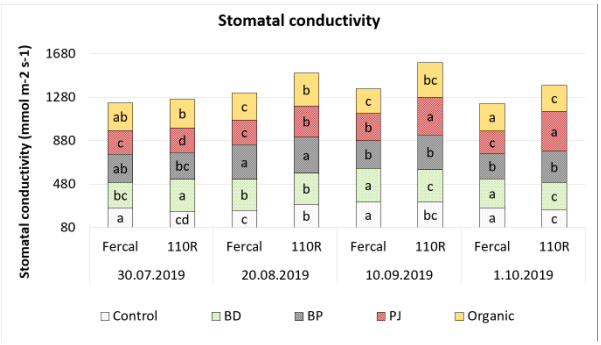

Figure 1
Effects of mulch applications on stomatal conductivity (mmol m^{-2} s^{-1}).

Leaf temperature (°C)

The effects of mulch applications on leaf temperature (Figure 2) were also important in 4 measurement periods ($p < 0.05$). While the BP application in the Fercal rootstock gave the highest leaf temperature as a value of 31.02 °C on July 30, the PJ application gave the highest value in 110R rootstock as 32.06 °C. On 20 August, OM application on both rootstocks [(Fercal 29.40 °C and 110R 29.60 °C)] gave the highest leaf temperature values. On September 10, BP applied samples were on both rootstocks [(Fercal 31.57 °C and 110R 31.33 °C)] had the highest temperature value. In the determinations dated 1 October, the application of OM in both rootstocks [(Fercal 30.23 °C and 110R 30.23 °C)] gave the highest leaf temperature. According to the data obtained, it increased the leaf temperature of BP, OM and PJ applications, respectively. In a previous study, Doğan (2020) reported that the effects of different mulch applications were significant in the

grape variety of Trakya İlkeren, and were listed as Control (33.46 °C), Straw (32.80 °C), BP (32.79 °C) and Pumice (32.61 °C) mulches.

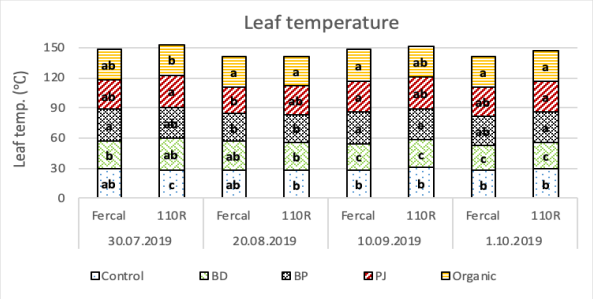

Figure 2
Effects of mulch applications on leaf temperature (°C)

Leaf chlorophyll content (spad value, mg kg^{-1})

The effects of mulch applications on leaf chlorophyll content (Figure 3) were also significant in 4 measurement periods ($p < 0.05$), BP and PJ increased leaf chlorophyll content more than the other applications. In the measurements performed on 30 July and 20 August, PJ application gave the highest Spad values in the Fercal rootstock as 23.42 mg kg^{-1} ve 26.48 mg kg^{-1} and in 110R rootstock BP application has the highest value as 7.29 mg kg^{-1} and 27.50 mg kg^{-1} respectively. On September 10, BP mulch had the highest leaf chlorophyll value in both rootstocks [(Fercal 26.91 mg kg-1 and 110R 25.27 mg kg^{-1})]. On October 1, PJ application in Fercal rootstock gave the highest SPAD value as 27.92 mg kg^{-1}, while OM gave the highest leaf chlorophyll value as 26.43 mg kg^{-1} in 110R.

In a similar study, Doğan (2020), reported that in the combination of Trakya İlkeren / 1103P, in 50% irrigation and BP mulch has the highest leaf chlorophyll content as 38.8 mg kg^{-1} compared to other mulch applications. Zengin (2019), reported that synthetic mulch applications significantly increased leaf chlorophyll content in their study with different rootstocks of 99R, 44-53M, Rupestris du Lot and 41B. Curtis (2013), reported that leaf chlorophyll content was greater than control as 39.9 mg mg kg^{-1} in those who applied OM in the *Vitis vinifera* vineyard, and increased vine growth and productivity.

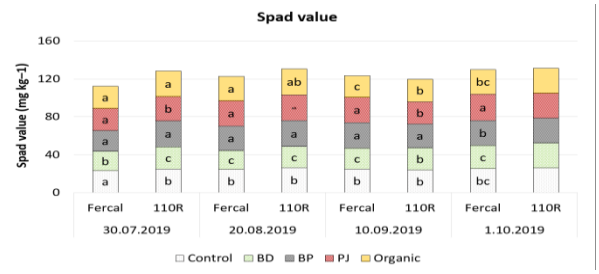

Figure 3
Effects of mulch applications on leaf clorophil content

Soil temperature (°C)

The effects of mulch applications on soil temperature (Figure 4) were significant ($p < 0.05$). According to the applications in both rootstocks, a stable condition was not observed in soil temperature values. The soil was the hottest in both rootstocks (Fercal 23.17 °C and 110R 23.00 °C) on which BP was applied at July 30. On August 20, PJ application in Fercal rootstock gave the highest soil temperature as 23.17 °C, and 110R rootstock as 22.80 °C. On September 10, in 110R rootstock, the highest soil temperature was determined in OM application as 21.83 °C, while the effects of applications on soil temperature in Fercal rootstock were statistically insignificant. In the last determinations made on 1 October, Fercal control gave the highest soil temperature value, while the effects of the applications on soil temperature were insignificant in 110R.

In one of the previous studies, Dağ (2017), achieved the highest soil temperature in BP application the Michele Palieri / 41B combination as 25.3 °C and indicated that this value was 3.7 °C higher than the control. Abramova (1984), reported that the application of synthetic mulch in the production of Areni and Burmunk grape vine saplings increased the soil temperature by 1.5-3 °C. Küçükyumuk (2009), stated that in the production of Alphonse Lavallée grapevine grafted onto 140 Ru, 5BB, 41B rootstocks, soil temperatures are listed as BP, Rose pulp, Control and Grass residue mulch applications from high to low. Zenginoğlu (2015), stated that in the combination of Sultani Çekirdeksiz / 1613, in the production of vine saplings, different mulch applications were compared and the soil temperature was higher in BP and upper surface gray bottom surface black mulch applications, and mulch applications had an effect on increasing soil temperature.

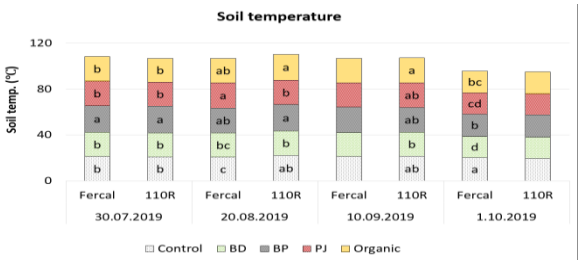

Figure 4
Effects of mulch applications on soil temperature (°C),

Leaf area (cm2)

The effects of mulch applications on leaf area (Figure 5) were significant ($p < 0.05$) and differed by rootstocks. In Fercal grape vine rootstock, all applications were above the control and the highest value as 143.50 cm2 was in the BP application, while in 110R rootstock the highest value as 66.75 cm2 was recorded in OM application. In a similar study previously conducted, Zengin (2019) reported that in the 41B rootstock, BP and OM applications increased leaf temperature up to 51% and 48%, respectively.

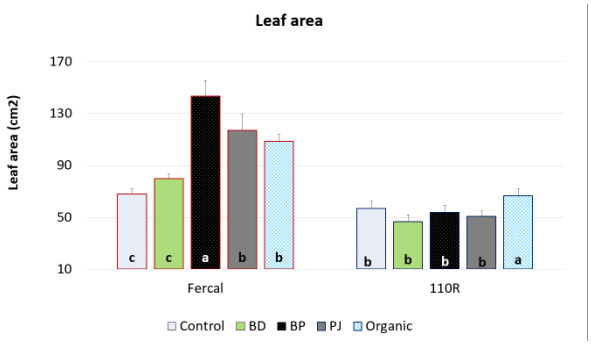

Figure 5
Effects of mulch applications on leaf area (mg kg^{-1}).

Number of leaves and roots (pieces)

The effects of mulch applications on the number of leaves (Figure 6) were significant ($p < 0.05$) and differed by rootstocks. OM application gave the highest number of leaves in both rootstocks (Fercal as 30.13 pieces and 110R as 29.05 pieces. All mulch applications in Fercal rootstock, BP and OM applications in 110R rootstock increased the number of leaves. While the highest number of roots was determined as 28.83 in BP application in Fercal, it was determined as 15.28 in OM application in 110R rootstock. In similar studies, In a similar study, Zengin (2019) reported that the application of OM on 99 R, 44-53 M, Rupestris du Lot and 41B grape rootstocks increased the number of leaves up to 30%. Dağ (2017), Zenginoğlu (2015), Küçükyumuk (2009) obtained the highest number of roots from BP application.

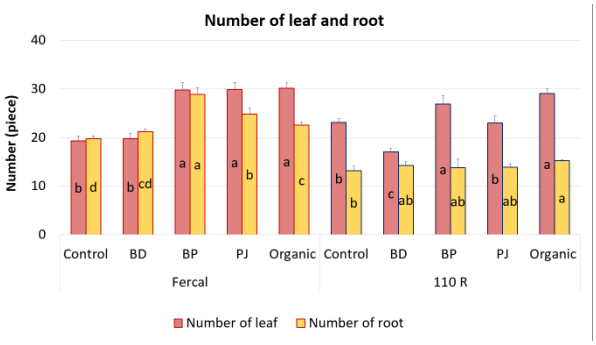

Figure 6
Effects of mulch applications on number of leaf and root (pieces).

Leaf weight (g)

The effects of mulch applications on leaf weights (Figure 7) were significant ($p < 0.05$). In Fercal, BP (3.30 g fresh 1.14 g dry) mulch gave the highest fresh leaf weight, whereas fresh and dry leaf weights were above the control in all applications. While the highest fresh leaf weight value was determined in OM (1.50 g) application in 110R, the difference between dried samples was insignificant ($p < 0.05$). In similar studies by Zengin (2019), and Ross (2010), mulch applications have been reported to increase fresh leaf weight. Zengin (2019), reported that the application of leaf dry weight BP (0.93 g) increased in the Rupestris du Lot rootstock.

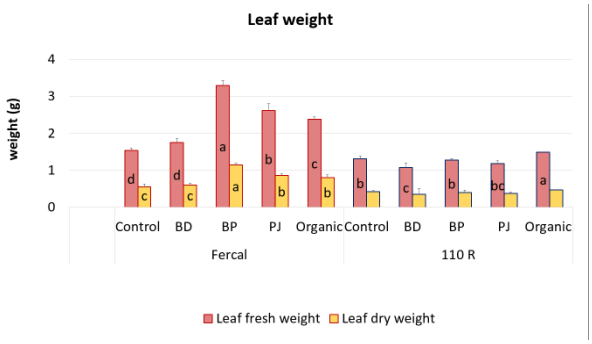

Figure 7
Effects of mulch applications on leaf weight (g).

Shoot length (cm)

The effects of mulch applications on total and lignified shoot length (Figure 8) were significant ($p < 0.05$) and the values were more than 110R in Fercal. In Fercal rootstock, the highest total as 130.73 cm and woody as 121.87 shoot length was recorded in BP application, followed by PJ and OM applications. In this rootstock, the shoot length values obtained from the BD application remained under control. In 110R, OM application came to the fore with the total as 94.76 cm and woody as 86.31 cm shoot length value. In previous studies where BP application increased the length of shoots, it was reported by Zengin (2019), Dağ (2017), Zenginoğlu (2015), Küçükyumuk (2009), Van der Westhuizen (1980).

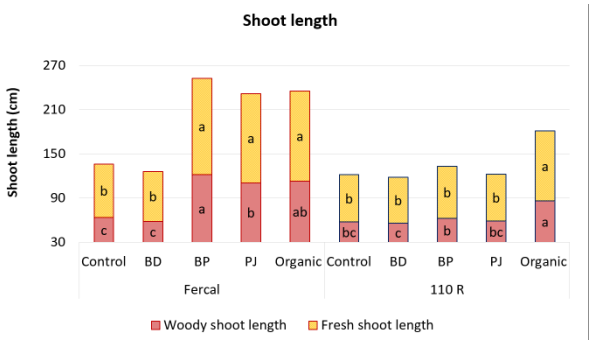

Figure 8
Effects of mulch applications on shoot length (cm)

Shoot and root diameter (mm)

The effects of mulch applications on shoot and root diameter (Figure 9) were significant ($p < 0.05$), differed by rootstocks (Figure 2), and in the same trend with shoot length, and the values were more than 110R in Fercal. The highest shoot length in BP application as 5.97 mm in Fercal and OM application as 4.89 mm in 110R gave the highest values. OM application [(Fercal 2.65 mm and 110R 2.80 mm)] gave the highest root diameter in both rootstocks, followed by PJ and BP applications with close values. In similar studies, where in BP application increased the diameter of the shoot, it was reported by Zengin (2019), Dağ (2017), Küçükyumuk (2009).

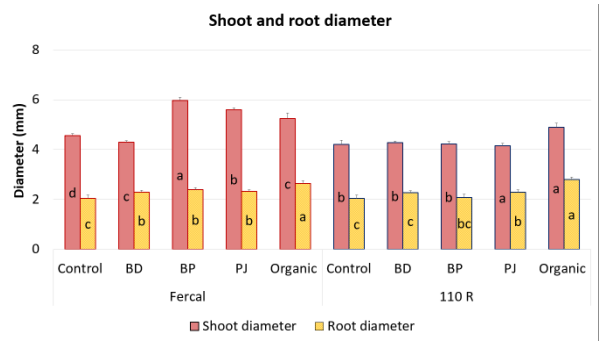

Figure 9
Effects of mulch applications on shoot and root diameter (mm).

Pruning residue weight (g)

The effects of mulch applications on pruning residue weight were significant ($p < 0.05$) and different from rootstocks (Figure 10) and the values were more than 110R in Fercal. The OM application gave the highest pruning residue weight as 31.88 g in Fercal rootstock and 17.54 g in 110R rootstock. Similar effects of BP application were reported by Dağ (2017) and Küçükyumuk (2009).

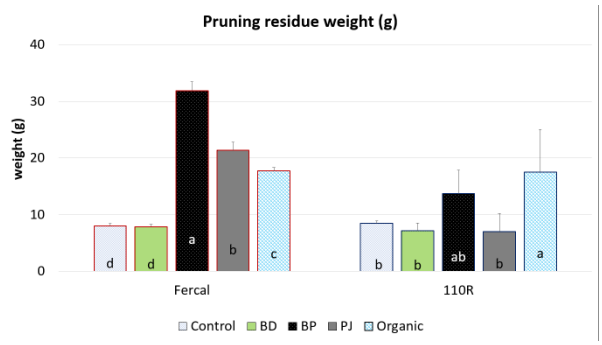

Figure 10
Effects of mulch applications on Pruning residue weight (g).

Shoot and root development level (0-4 scale)

BP, PJ, and OM applications significantly increased the shoot growth ($p < 0.05$) (Figure 11) in Fercal and the only OM in 110R, and all mulche inreased root developemnt in both rootstocks. In Fercal, BP (3.09) and PJ (3.03) gave higher values than the control and BD applications. The highest shoot development in 110R was obtained by the OM (2.49) application. Root growth level in Fercal gave the highest root scale in PJ (3.83) application, while BD (3.06) application in 110R.

In previous studies, Zenginoğlu (2015) reported that Sultani Çekirdeksiz / 1613 saplings were the highest shoot development level in BP (2.9) application. Küçükyumuk (2009) reported that BP application significantly increased the level of shoot growth compared to other mulch applications in the production of Alphonse Lavallée grapevine grafted onto 140 Ru, 5BB, 41B. Dağ (2017), Michele Palieri / 41B had the highest shoot growth level in sapling production as 2.10 scale from BP application. In similar studies conducted by Dağ (2017), Zenginoğlu (2015), Küçükyumuk (2009) it was reported that BP applications significantly increased the level of root development.

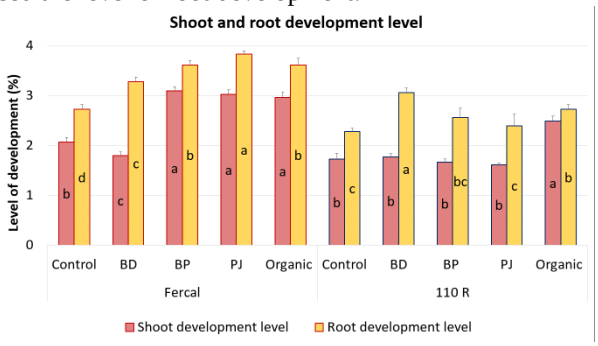

Figure 11
Effects of mulch applications on shoot and root development level (0-4 scale).

Root fresh and dry weight (g)

All of the mulch applications significantly increased the root fresh and dry weight ($p < 0.05$) (Figure 12) and the values were more than 110R in Fercal. In Fercal, BP (25.78 g) and OM (24.90 g) applications significantly increased the root fresh and dry (12.00 g and 11.97 g) weight. The highest root in Fercal rootstock was obtained from BP application with its fresh weight. The highest root fresh (7.05 g) and dry weight (3.54 g) were determined in OM application at 110R rootstock. In similar studies, Dağ (2017), Küçükyumuk (2009) reported that the application of BP increases the root age weight of 41B grapevine seedling production. Van der Westhuizen (1980) reported that vines with plastic mulch have higher root weight due to higher soil moisture. Van Huyssteen and Weber (1980) obtained higher hanging root density from OM than other mulch applications.

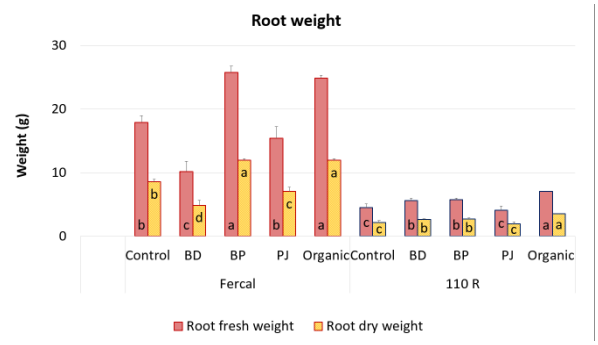

Figure 12

Effects of mulch applications on root weight (g).

Sapling efficiency (%)

BP and OM applications increased the 1st and 2nd grade seedlings efficiency ($p < 0.05$) (Figure 13) and the values were more than 110R in Fercal. The highest 1st (28.33%) and 2nd grade (44.17%) seedlings yield in Fercal were obtained by BP application, and in 110R, it was obtained by BD and OM application (49.17%, 20.00%, respectively). In similar studies, Dağ (2017), Küçükyumuk (2009), Zenginoğlu (2015) BP application significantly increased the yield of 1st and 2nd grade seedlings in vine sapling production, Zengi-

noğlu (2015), black mogul (17.5) mulch application in the production of open-rooted vine seedlings. He reported that he gave a high 2nd grade sapling yield value. Akman (2009), reported that in the production of seedlings in the combination of Tekirdağ Çekirdeksizi / 5BB, the second-grade seedlings yield was 14.84 in control, while the efficiency in mulch applications remained lower with 12.25.

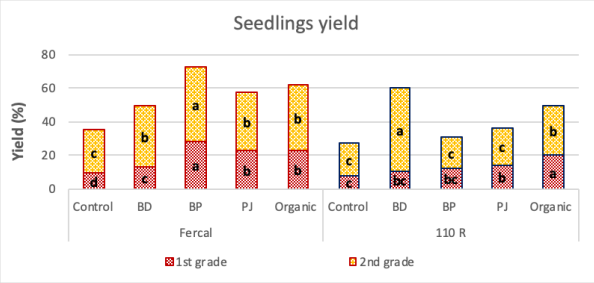

Figure 13
Effects of mulch applications on sapling yield (%).

4. Conclusion

Mulch practices had significant effects on all the characters examined and the overall efficacy rank varied according to the character and rootstocks. Vegetative development was more than 110R in Fercal. Stomatal conductance values were higher in 110R than Fercal, but when measurement times and applications were evaluated together, there was no stable situation in both rootstocks. While the leaf temperature increasing effect, order was determined as SP, OM and PJ, and the efficiency of increasing leaf chlorophyll content was listed as SP, PJ and OM. No stable variance was observed in soil temperature values, the activity from high to low was listed as BP and PJ and OM, BD.

In the Fercal grapevine rootstock, the leaf area was above the control in all applications and the efficacy order was determined as BP, PJ, OM, BD and Control, while the single value above the control in 110R was determined in the OM application.

While OM, BP and PJ applications increased the number of leaves in both rootstocks, others were in the same group with control.

The order of activity in increasing leaf weight was BP, PJ, OM, BD in Fercal. In the 110R rootstock, the effect of BD and PJ remained limited, while OM and BP increased leaf weights.

The effects of mulch applications on total and woody shoot length were listed as in Fercal, BP, OM and PJ, while BD and BD were in the same group with control. In the 110R rootstock, OM application increased the total and lignified shoot length, while the others were in the same group with control.

While the pruning residue weight increased in Fercal BP and PJ, OM applications significantly, BD was in the same group with the control. In the 110R rootstock, OM and BP applications increased the pruning residue weight, while PJ, BD and control were in the same group.

All the applications of mulch increased the level of shoot and root development. While the activity was ranked as BP, PJ and OM in Fercal, BD remained under control. In the rootstock 110R, only OM significantly increased the level of growth, while other applications were in the same group with control. While all applications increased in root development levels, the ranking was BD, OM, BP, PJ and Control.

BP, PJ, OM and BD applications in Fercalde, and OM and PJ applications in 110R increased the diameter of shoots. In Fercal root diameter was affected by the applications in the same way as shoots and the activity was listed as BP, PJ, OM and BD. In 110R, OM, PJ and BP applications increased the root diameter.

When the root fresh and dry weight were evaluated together, in Fercal BP and OM, and in 110R, OM, BP and BD came to the fore.

The efficiency of the applications for total seedling efficiency and 1st and 2nd grade seedlings efficiency were listed in Fercal in the same way (BP, OM, PJ and BD) and BB, OM, PJ and BP in 110 R.

Since, significant differences were found at the level of the examined characteristics in both rootstocks, it may be recommended to select mulches according to the effect expected from mulch applications in the future studies.

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Conflict of interest

Z. Kara, M.S.M. Fakhar, declare that they have no competing interests.

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