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Do Microbial Fertilizer Applications Affect the Yield and Essential Oil Ratio in Mint (*Mentha piperita* L.) Cultivars?

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Abstract

Recently, excessive and unconscious uses of chemical fertilizer cause significant hazards on natural resources and subsequently cause serious environmental problems. As an alternative instead of chemical fertilizer, microbial fertilizers are used for healthier soil and plant. The aim of this study was to determine the effect of different doses of microbial fertilizers on yield and essential oil ratio in Mint (*Mentha piperita* L.) cultivars. The experiment was carried out in a pot according to the randomized parcel design. The study was carried out with three cultivars namely, *Mentha piperita* swiss, M. *piperita* chocolate, M. *piperita* multimentha, four doses (control, 1, 1.5 and 2 doses) and three replicates. In the study; plant height (cm), fresh herb yield (g/m^2), drog herb yield (g/m^2), drog leaf yield (g/m^2), essential oil ratio (%) and essential oil yield (L/m^2) were examined. Along with the study, Microbial fertilizers exhibited significant effects on the parameters examined herein. The yield of fresh herb yield and drog leaf yield were found between 1342.5-2001.1 g/m^2, 160.9-228.0 g/m^2 respectively and the essential oil ratio varied between 1.55-1.93% according to microbial fertilizer doses.

Key Words: *Mentha piperita,* Microbial Fertilizer, Yield, Essential Oil Ratio

1. Introduction

From prehistoric times to present time, plants met many demands of human beings for their many uses. Of the plant groups, medicinal and aromatic plants have gained great interest among people due to side effects of synthetic and semi-synthetic pharmaceutical agents (Gezgin 2006). Various and numerous functions and uses including food, medicine, cosmetics and spices have been attributed to those plants. The mentioned uses have also been common since the beginning of human history. Those plants are gathered either from the wild or cultivated and produced (Demirezer, 2010).

Of the significant medicinal and aromatic plants, mint (*Mentha* sp.) belonging to Lamiaceae (Labiatae) widely spreads over the world but mainly concentrated in Central Europe and Asia. In Turkey, it can be grown everywhere (Demirez, 2013). Of the *Mentha* spp., peppermint (*Mentha piperita*), Japanese peppermint (*Mentha arvensis*) and spearmint (*Mentha spicata*) are the most important species cultivated in the world (Baydar, 2016).

Mentha species possess essential oils varying between 1 and 4%. Regarding major essential oil components, *M. piperita* and *M. arvensis* species are characterized with menthol and mentone while carvone is of the major components of *M. spicata* (Baydar, 2016; Karakaplan, 2017).

Fresh shoots and leaves of mint are used as a seasoning for meals and added to salads in Mediterranean countries. It is used as a fresh vegetable in traditional Turkish cuisine and takes its place in salads. A significant portion of the mint is used as powder by being dried and packaged by various companies for sale or used by the producers (Demirez, 2013).

Peppermint largely requires nitrogen and potassium fertilizers. It has been found that although potassium fertilizer decreases the essential oil ratio, nitrogen increases yield and essential oil ratio. Both potassium and phosphorus fertilizers should be given according to the results of soil analysis. Mint demands nitrogen fertilizer and requires plenty of organic fertilizer. Fertilizer is most needed between the buds and flowering cycles (Megep, 2016).

In addition to the chemical fertilizers, biofertilizers exhibit significant effects on biomass of the plants, suppressing the soil harmful pathogens and increasing the effectiveness of other beneficial bacteria. Consequently, biofertilizers are of the alternative methods used to establish the balance between plant and soil microorganisms. With the present study, different doses of microbial fertilizers on yield and quality of different mint cultivars were examined.

2. Materials and Method

The study was conducted as a pot experiment in the randomized parcel experiment design in Medical and Aromatic Plants greenhouse of Field Crops Department. Commercially available Microbial fertilizer was used in the experiment.

The study was carried out with three cultivars, four doses (control, 1, 1.5 and 2 doses) and three replications. Recommended microbial fertilizer dose by company is 100cc to 1000 lt water. Recommended dose used as 1 dose in study and other doses were adjusted according to it. Prior to planting, 0.5 liters of water was put into 12 buckets and then the microbial fertilizer applied in these buckets and mixed. Only water was put in to buckets for control application. In the meantime, 10 stolon were cut from each three mint cultivars with the help of hand pruners. These stolons were put into buckets for each dose application and kept for 1 hour. The pots 72 cm long, 13 cm wide and 13 cm high were used in the experiment and filled with soil up to 8 cm high. These pots were planted with 10 pieces of 10 cm stolon after 1 hour. Extra soil was added to the top of the planted stolon and the soil was compacted and watered. Each pot was considered as a parcel. The total experiment consisted with 36 pots. Mint stolons planted to pots in 18 February 2019 and harvest was made after 75 days later in 3 May 2019.

The statistical analysis of the data was performed according to the SAS package program and the differences between the averages were grouped according to the significance level (5% or 1%) in LSD test.

3. Results and Discussion

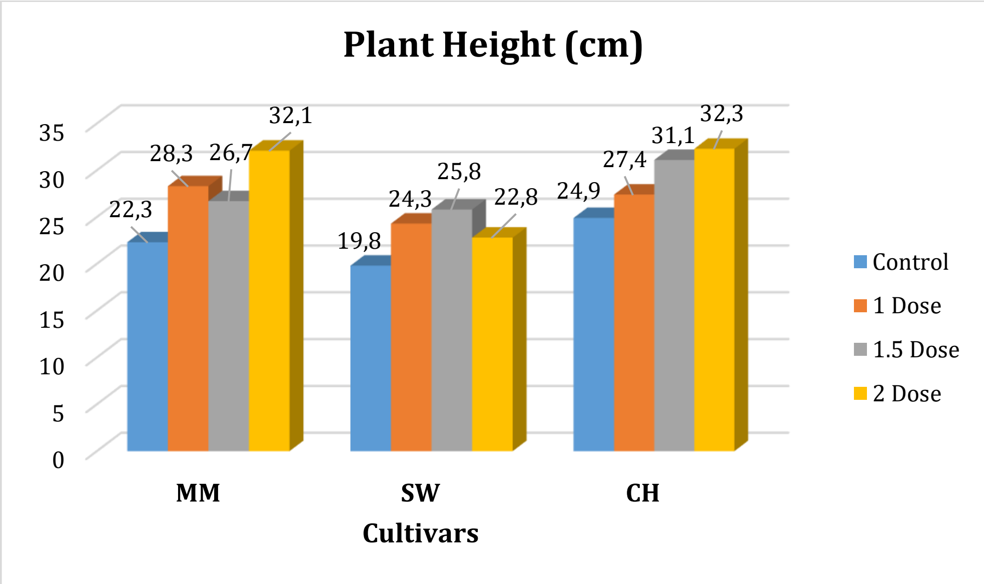
In order to determine the effects of microbial fertilizer applications on *Mentha piperita* cultivars in Aydın greenhouse conditions, F values and significance levels were determined by variance analysis and significant features were grouped.

3.1. Plant height (cm)

Cultivar x dose interaction was found significant. The highest plant height belongs to chocolate cultivar 2 doses (32.3 cm) and the shortest plant height was found in the swiss cultivar control application (19.8 cm) (Figure 1). Mint species can grow up to 100-

150 cm (Kokkini, 1983). First cultivation year of mint (2016), plant height (cm) was found between 45.4-75.8 cm in first harvest, 32.5-47.4 in second harvest and in second year (2017) first harvest 39.5-73.2 cm, second harvest 20.8-58.2 cm (Yılmaz, 2018).

It can be said that the differences between this study and other studies are due to the early harvesting (before flowering) and the doses of microbial fertilizer.



MM: Multimentha, SW: Swiss and CH: Chocolate

Figure 1. Effect of cultivars and doses on plant height (cm)

3.2. Fresh Herb Yield (g/m²)

The highest fresh herb yield value was obtained as 2001.1 g/m^2 in multimentha cultivar (Figure 2). There is no significant effect of microbial fertilizer on fresh herb yield. Yılmaz (2018) has found that fresh herb yield of different mint cultivars vary between 387.3-2493 kg/da and multimentha cultivar has the highest fresh herb yield than other mint cultivars (Swiss, Chocolate, Citaro and Piperita T.). In our study, It is clear that our results similiar with Yılmaz (2018) findings. However, our fresh herb yield is 2001.1 (kg/da) lower that researcher due to first year harvest. It can be said that if there is harvests in second year, our finding might be higher than researcher.

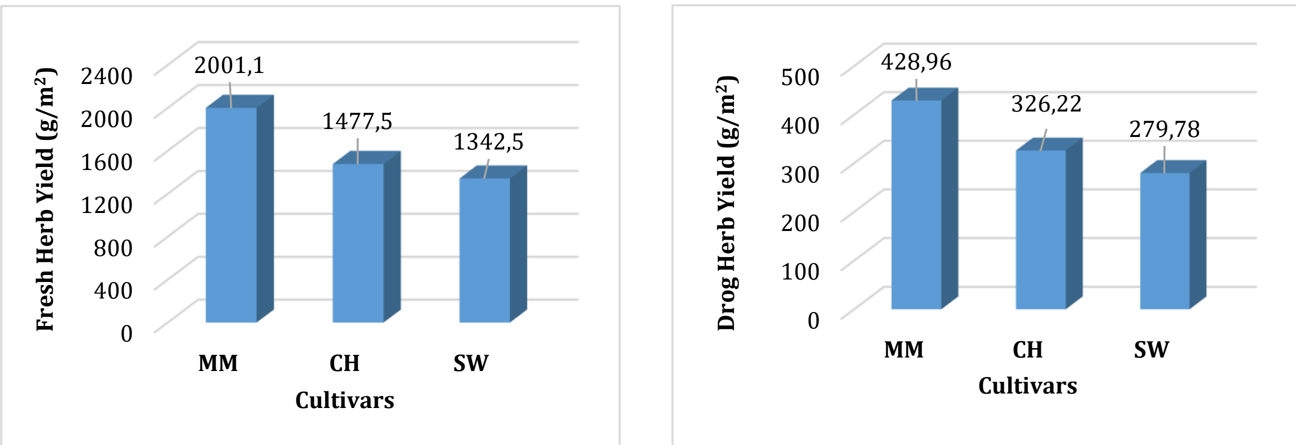


Figure 2. Effect of cultivars on fresh herb yield and drog herb yield (g/m^2)

3.3. Drog Herb Yield (g/m²)

The highest drog herb yield was obtained as 428.96 g/m^2 from multimentha cultivars. The lowest yield value was found 279.78 g/m^2 from the swiss cultivar and in the same statistical group with Chocolate cultivar (Figure 2).

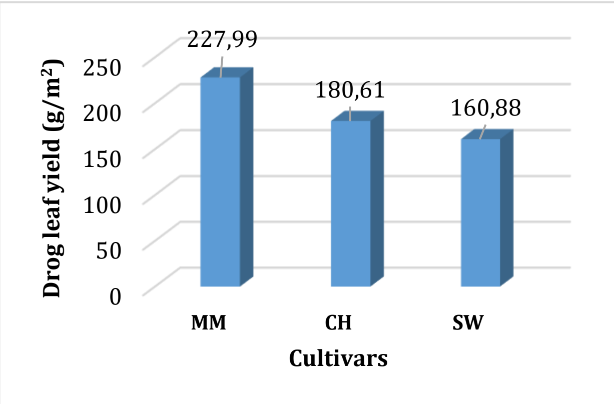
According to Yılmaz (2018) results drog herb yield vary between 263.6–457 kg/da and multimentha has the highest drug herb yield with 457 kg/da in first harvest of first year.

Our study results were found similiar with researcher. Drog herb yields in mint vary according to the climatic conditions of the plant (Piccaglia and Marotti, 1993; Özgüven and Kırıcı, 1999) and growing conditions (Munsi, 1990; Court et al., 1993; Alkire and Simon, 1996). These low yield cultivars awaking late in the spring and show better development in heat. Drog herb yields in mint vary according to the genetic structure of the plant (Ceylan, 1987; Özgüven and Kırıcı, 1999; Tuğay et al., 2000).

3.4. Drog Leaf Yield (g/m²)

Dried leaves of mint are used as spices so drog leaf yield is an important yield element in mint. In the study, effect of the cultivars on the drog leaf yield was found significant (Figure 3). However, the doses were not statistically significant but it can be said that one dose has highest value (Figure 3).

The highest value for drog yield was obtained from multimentha cultivars (227.99 g/m^2), while the lowest value was obtained from swiss cultivars (160.88 g/m^2). Yılmaz (2018) found that drog leaf yield changed between 173.5-183.9 first harvest of first year and the highest drog leaf yield belongs to multimentha cultivar.



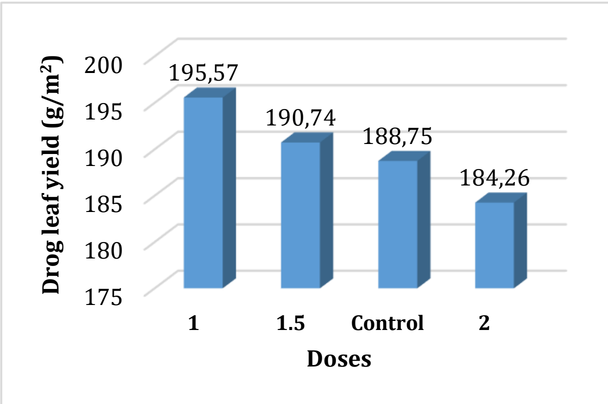
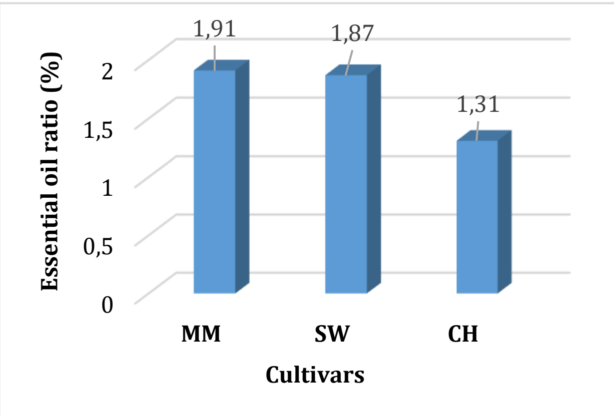


Figure 3. Effect of cultivars and doses on drog leaf yield (g/m^2)



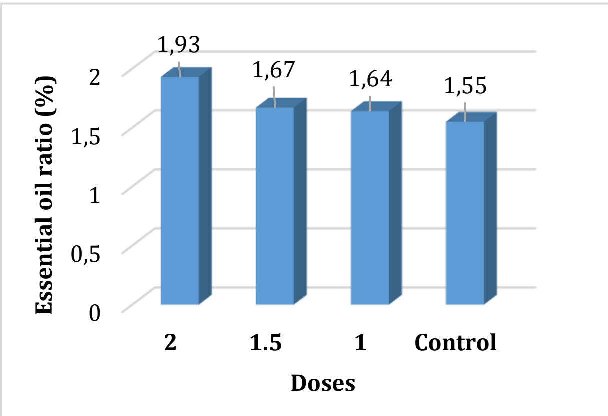


Figure 4. Effect of cultivars and doses on essential oil ratio (%).

3.5. Essential Oil Ratio (%)

The highest value of essential oil ratio in multimentha cultivar was found 1.91%, followed by swiss cultivar with 1.87% and chocolate with 1.31%, respectively (Figure 4). The highest value of essential oil ratio was found in 2 time doses (1.93%) of microbial fertilizer and the lowest essential oil ratio was found in control with 1.55% (Figure 4).

When the previous studies were examined, Yılmaz (2018) essential oil ratio values ranged between 1.3-2.1% in first year (2016). In the second year (2017), the essential oil ratios ranged between 2.2-3.2%. In previous studies on mint; it was determined that essential oil ratio vary according the plant's genetic structure, climate condition and different application in cultivation (Ceylan, 1987; Munsi, 1990; Piccaglia and Marotti, 1993; Court et. al., 1993; Alkire and Simon, 1996; Ozguven and Kırıcı, 1999; Tugay et al., 2000).

3.6. Essential Oil Yield (L/m²)

In the study, the highest essential oil yield values were obtained from multimentha cultivar and the essential oil yield was determined as 4.31 L/da. The lowest essential oil yield (L/da) was found as 2.37 L/da in chocolate cultivar (Figure 5).

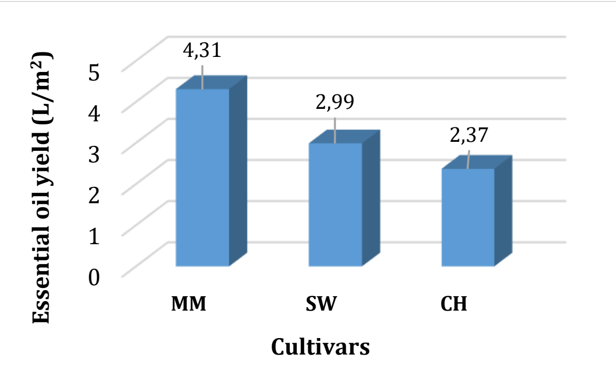


Figure 5. Effect of cultivars on essential oil yield (L/m²).

When the previous studies were examined; Yılmaz (2018), was found the essential oil yields in the first year of the study (2016) between 4.0-7.2 L/da in the first harvest and 1.2-5.5 L/da in the second harvest.

4. Conclusions

Fresh herb yield, drog herb yield and drog leaf yield although there was no effect of the doses, the multimentha cultivar has the highest yield values. Technological properties (essential oil ratio and essential oil yield) were economically valuable features and values of these features reached the highest values with 2 time dose and multimentha cultivars.

If it is desired to produce fresh herb yield, drog herb yield and drog leaf yield, it is recommended to use multimentha cultivar. Or if it is desired to produce essential oil ratio, it is recommended to use 2 times microbial dose and multimentha cultivar.

Our yield results found to be higher than other researchers except essential oil ratio and essential oil yield due to early (before flowering) harvest. However, our study was conducted Piccaglia in greenhouse condition in pots so results might be different in field condition. It is useful to enrich this study with another study in field conditions.

Conflict of Interest

The authors declare that they have no conflict of interet.

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