The Growth of Mycorrhizal and Non-Mycorrhizal Forsythia X Intermedia Zab. Plants under Different Climate and in Various Growing Medium

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Abstract:

Water matter and aridity has started getting a big threat for the plants even excluding in the problematic areas by resulting of global warming and significant air temperature increase in summer at the present time. As a result the plant development slows down, the nutrition relations are affected negatively, plants remain weak, they cannot give the desired effect and in some cases death occurs. In planting studies that will be made in such problematic areas, mycorrhizal plants are used in order to minimize the problems.

The aim of this study is to investigate the difference between the growths of plants with and without mycorrhiza in vegetation studies that will be made in arid regions. For this purpose, mycorrhiza effects are experienced on Forsythia x intermedia plants which are preferred at landscape architecture designs because of its common existence in dense-massive vegetative designs and their functional and esthetic properties. Mycorrhizal and non-mycorrhizal Forsythia x intermedia saplings were planted in S, SS, SSO medium at three test areas with different annual rainfall values. By taking measurements once in every three months; the root length, number of shoots and distance between nodes were determined.

Key Terms: Vesicular-Arbuscular Mycorrhiza, Forsythia x intermedia, drought stress, plant growing

Introduction:

The plants at planting works in rural-arid areas where ecological problems are much can be protected from the drying effects by additive of organic materials, watering and caring consistently. The plants don’t grow good or die because of these applications cannot be done or uncompleted in many areas. Consequently planting applications fail. Recently, water matter and aridity has started getting a big threat for the plants even excluding in the problematic areas by a result of global warming and significant air temperature increase in summer. One of the solutions of these problems is to use plants which don’t need so much water. But sometimes these kinds of plants don’t have aesthetical quality like color, texture, etc. for landscape designing projects. Consequently mycorrhizal plants should be an option with low maintenance, irrigation and also high aesthetical quality. Mycorrhiza is the most commonly known coexistence between the plant roots and microorganisms. This coupling creates a line between the soil and the plant and plays an important role in water transfer (Marschner, 1995; Mukerji et al., 2000). While mycorrhiza helps the plant for absorbing soil minerals and soil water in an efficient way, the plant gives carbohydrates to the mycorrhiza, which are necessary for its development (Harley, 1989; Koide and Schreiner, 1992; Smith and Read 1997; Davies, 2000). Mycorrhiza is quite effective on soil structure and soil moisture. Mycorrhizal regulates soil structure and increases water holding capacity of the soil (Auge et al., 2001; Davies, 2000). In problematic fields with less humidity in the soil, mycorrhiza increases the plant's resistance to drought. With the help of its rootlets that can spread into earth, it can maintain water which far way to the plant (Cooper, 1984). These rootlets make it possible for the plants to benefit the water and nutrients in soil by extending towards into the soil especially in nutrient-poor soils (Jeffries and Dodd, 1991; Peterson and Bonfante, 1994). P and other nutrients have quite low ability to move in arid soil. Therefore mycorrhiza impact is very important nutrient intake. With the decrease of nutrient stress, the plant’s root development increases and water intake from soil is becoming more effective (Fitter, 1985; Smith and Read, 1997). Mycorrhiza increases the plants root surface area, therefore encourages the growth of plant roots for absorbing nutrients and water from soil. Along
with that, increases the drought resistance of the plant and decreases the need of watering and fertilizer. Also, it protects the plant roots from the negative effects of soil pathogens. Therefore, mycorrhiza supports the root development of the plants as well as helping the roots at water and nutrient intake processes (Marschner and Dell, 1994; Azcon et al., 1996; Davies, 2000).

In this study, the aim is to present the effects of mycorrhiza on plants at Landscape Architecture vegetation applications in provincial and city fields where the conditions are hard. In order to realize the aim of the study, the effects of mycorrhiza on survival rates *Forsythia x intermedia* plant, which is a preferred plant in landscape architecture vegetation applications due to its functional and esthetic properties, were investigated.

**Materials and Methods:**

In this study, 2 years old plants of the *Forsythia x intermedia* were used. In greenhouses, the plants were planted in polyethylene tubes of 2lt capacity separately. 3 different planting medium were prepared. For sterilization purposes not to have root infections, these mediums were left in autoclave under 121°C and 2 atmosphere pressure for 1 hour (Matsubara et al., 2000a). Prepared medium are:

1. Soil (S)
2. Soil + River Sand (1:1) (SS)
4. Soil + sterilization (Ss)
5. Soil + River Sand (1:1) + sterilization (SSs)

Burned animal fertilizer of two years was used as the organic matter. 4gr of *Glomus mosseae*, used as a mycorrhiza material, was inoculated for each plant in polyethylene tubes. The plants were also placed in these medium without inoculation (control groups). After mycorrhiza inoculation procedure, 500mg N (Nitrogen) and 200mg K (Potassium) was applied for each 2lt tube. Ammonium sulfate, triple super phosphate and potassium sulfate were used as fertilizer sources. The plants were watered twice in every week in a way such that same amount of water (~200ml) was supplied to each tube during the study. In the greenhouse stage, mycorrhizal and non-mycorrhizal *Forsythia x intermedia* plants grown in 6 different medium were planted in the application areas after 6 months. The plants were removed from the tubes and planted with their root surrounding medium in the application areas (Trabzon, Macka, Gumushane) with equal numbers and the study was done with 13 plants in each medium. The application areas were chosen among 3 regions with different annual amounts of rainfall and average temperature values. The 1st application area was in Trabzon with annual total rainfall of 806.0mm, the 2nd application area was in Macka town of Trabzon with annual total rainfall of 603.9mm, the 3rd application area was in Gumushane with annual total rainfall of 480.8mm. *Forsythia x intermedia* plants treated with mycorrhiza in greenhouse was again inoculated to mycorrhiza in the application area. 2gr of mycorrhiza was placed in the planting pit, the plants were removed from their polyethylene tubes and planted.

After the plants were planted in the application areas, watering was done in 3 different regions in May and June once in every week, and June-August twice in every week. No watering was done in fall and winter months, instead the plants were left in natural conditions. Special care was given for the plants to take equal amounts of water (~700ml) in each application area. At the end of area study, in order to observe the effects of the applications on plant growth, 3 plants were removed from each group in 3 different application areas. In laboratory, lengths of the plant roots measured with 1 mm precision in a tape measure and number of shoots of the plants was determined on the main body. At the same time distances between shoots measured and the mean of these values was recorded as the value of distance between nodes for each plants.
Results and Discussion:

The variance analysis results showing the effect of mycorrhiza and control applications on Forsythia x intermedia plants’ root length, number of shoots and distance between nodes in three different test regions along with arithmetical average and standard deviation values are presented in Table 1.

Table 1. The effects of mycorrhiza, fields and growing medium on the root length, number of shoots and distance between nodes of the Forsythia x intermedia

<table>
<thead>
<tr>
<th>Area</th>
<th>Medium</th>
<th>Root length (cm)</th>
<th>Number of shoots (item)</th>
<th>Distance between nodes (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mikoriza +</td>
<td>Mikoriza -</td>
<td>Mikoriza +</td>
</tr>
<tr>
<td>Gumushane</td>
<td>S</td>
<td>38.33 ± 4.9 a</td>
<td>29.67 ± 8.5 ab</td>
<td>18.33 ± 2.5 a</td>
</tr>
<tr>
<td></td>
<td>Ss</td>
<td>33.67 ± 10.0 a</td>
<td>24.00 ± 2.6 ab</td>
<td>21.00 ± 3.6 a</td>
</tr>
<tr>
<td></td>
<td>SS</td>
<td>38.33 ± 7.6 a</td>
<td>21.33 ± 4.2 a</td>
<td>25.00 ± 12.1 a</td>
</tr>
<tr>
<td></td>
<td>Ss</td>
<td>38.33 ± 2.9 a</td>
<td>31.67 ± 3.8 b</td>
<td>23.00 ± 12.3 a</td>
</tr>
<tr>
<td></td>
<td>SSO</td>
<td>36.67 ± 4.2 a</td>
<td>31.33 ± 2.3 b</td>
<td>16.67 ± 7.5 a</td>
</tr>
<tr>
<td></td>
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<td>28.00 ± 17.3 a</td>
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<td>Macka</td>
<td>S</td>
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<td>30.67 ± 3.5 ab</td>
<td>14.33 ± 5.8 a</td>
</tr>
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<td>36.67 ± 7.2 b</td>
<td>14.67 ± 2.1 a</td>
</tr>
<tr>
<td></td>
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<td>31.00 ± 1.7 ab</td>
<td>16.67 ± 3.8 a</td>
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<tr>
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<td>26.67 ± 4.7 a</td>
<td>16.67 ± 3.8 a</td>
</tr>
<tr>
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<td>29.00 ± 2.6 ab</td>
<td>17.67 ± 2.1 a</td>
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<td>18.00 ± 1.0 a</td>
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<td>Trabzon</td>
<td>S</td>
<td>50.33 ± 12.1 a</td>
<td>40.33 ± 9.6 a</td>
<td>17.00 ± 4.6 a</td>
</tr>
<tr>
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<td>34.33 ± 5.9 a</td>
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<tr>
<td></td>
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<td>20.00 ± 1.7 a</td>
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<td></td>
<td>SSOs</td>
<td>61.33 ± 7.6 a</td>
<td>46.33 ± 13.1 a</td>
<td>21.33 ± 10.7 a</td>
</tr>
</tbody>
</table>

SSOs: Soil+Sand+Organic Matter
The measurement time averages were compared on column bases according to Duncan test.

In Gumushane, Macka and Trabzon application areas at different growth medium, although the effect of mycorrhiza inoculation on the root length and distance between nodes values of Forsythia x intermedia are statistically significant level (P<0.05), the effect on number of shoots values are not statistically significant (P>0.05). In addition, it was found that the effects of field factors are statistically significant (P<0.05), the effects of medium factors on the plant number of shoots, root length and distance between nodes values of Forsythia x intermedia plants are not statistically significant (P>0.05).

Root length:

In Gumushane application area, it was determined that plants with mycorrhiza had higher root length values as compared to control plants at all of medium. It was observed that the difference between mycorrhizal plants and control plants root length values were found to be more prominent. In when the plant root length values in Macka application area were investigated, in all of medium except Ss medium, it was seen that mycorrhizal plants had higher root length than control plants. In Trabzon application area, it was observed that the root length values of mycorrhizal plants were higher than non-mycorrhizal plants. Especially in Ss medium this difference is quite apparent (Figure 1).
In application areas, it was observed that mycorrhiza inoculation was effective on the root length. Mycorrhiza had encouraged the plants to have better and qualified root growth.

In similar study, it was found that mycorrhiza increases root length of *Prunus cerasifera* which is a preferred species in planting design because of its esthetical properties, leaf colour and flowers beauty. At the same time it was declared that mycorrhizal plants’ shoot number are higher as compared to control plants (Berta et al., 1995).

Mycorrhiza has a crucial role in healing the root diseases in addition to the fact that it increases the resistance of the plants under negative conditions. In the studies carried out to find out the effect of mycorrhiza on the rotting disease in the roots, it is stated that mycorrhiza inoculation has a positive effect on the rotting problem in *Asparagus officinalis* L. plants and reduce the plant deaths to minimum (Matsubara et al., 2001; Matsubara et al., 2000b).

**Number of shoots:**

In Gumushane application area, it was found that mycorrhiza inoculation was effective in Ss, SS, SSs and SSOs medium on shoot numbers. Especially, in SSOs medium, it was seen that shoot numbers of plants with mycorrhiza inoculation were more than control plants; whereas control plants had more shoot numbers in S and SSO medium. In Macka application area, it was determined that shoot number of mycorrhizal plants are more than those control plants in S, SS, SSs and SSOs medium. In Ss and SSO medium, control plants have more shoot numbers than mycorrhizal plants. In Trabzon application area, it was found that shoot number of plants with mycorrhiza had more as compared to control plants in Ss, SSs and SSOs medium. But in S, SS and SSO medium, control plants had more shoot numbers. Especially, in S and SSO medium this difference is quite evident (Figure 2).
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Under the same conditions, in the study on Cotoneaster franchetti, mycorrhizal plants formed a good root structure and increased their shoot numbers clearly in Gumushane application area (Pulatkan, 2010). In Trabzon application area, because annual rainfall value is higher as compared to other application areas, the plants had growth well without stress. Also, mycorrhiza inoculation was encouraged this growing. Especially, in Gumushane application area, plants had water stress, so they not better growth as compared to other application areas.

**Distance between nodes:**

In Gumushane application areas, it was found that mycorrhizal plants in only S medium had higher distance between nodes value than control plants with a slight difference. In other medium, values of control plants were higher as compared to mycorrhizal plants. In Macka application area, it was observed that distance between nodes of control plants were higher than mycorrhizal plants in all medium. Especially the difference between the two groups is quite evident in SSO and SSOs medium. In Trabzon application area, it was found that mycorrhizal plants’ distance between nodes values were higher in S medium, whereas control plants’ values were higher in other medium (Figure 3). It was measured that distance between nodes were higher in control plants in all medium, whereas it was seen that mycorrhiza was effective on the number of shoots on plant. Control plants without mycorrhiza had less shoot and longer distance between nodes, whereas mycorrhizal plants had more shoot and more close distance between nodes with these data.

**Figure 2.** Effects of mycorrhiza and control process on Forsythia x intermedia plant’s number of shoots in different application areas and different medium
In the study on *Ipomea carnea* sups. *fistulasa* inoculated with different types of mycorrhiza, it was found that root, leaf, shoot and total dry plant weight; number of leaves, shoots and buds in mycorrhizal plants were more than control plants’ values (Carpio, 2002). It was mentioned that with mycorrhiza inoculation the total plant weight and number of shoots increases in *Abutilon theophrasti* which is a preferred species in vegetation designs like *Forsythia x intermedia* because of its esthetical properties (Koide, 2000). In a similar study made with *Rosmarinus officinalis* plant subjected to water stress test, it was found that with mycorrhiza inoculation the heights of plants increase and they developed better (Sanchez-Blanco et al., 2004).

**Conclusions:**

In this study, it was found that mycorrhiza application encouraged the growth of *Forsythia x intermedia* plants and helped to create a good root structure in the regions with low rainfall values and having drought problems. In the fields’ of regions without drought problem, no big difference was seen between plants with mycorrhiza inoculation and other plants.

When the application areas in general, it was observed that a mixture of soil + sand + organic matter was the best planting medium in six different growth medium. In order to increased mycorrhiza infection and contributed to the growth of plant, organic materials should be used in addition to mycorrhiza during planting.

This is desired property for plants which to be used in vegetation designs. Especially in the vegetation studies that will be made in droughty regions with limited water supplies and where caring possibilities are low, mycorrhiza inoculation plant will create a good form and give the desired impression.

**Acknowledgements:**

This study was accepted as project and supported by KTU Scientific Research Projects Department with grant no 2005.113.03.3.

**References**


Pulatkan, M. 2010. Effects of Inoculation with Mycorrhiza on *Forsythia x intermedia* Zab. and *Cotoneaster franchetti* Bois. Plants under Different Climate Conditions and in Various Growing Medium. PhD dissertation, Karadeniz Technical University, Trabzon, Turkey.
