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Full Length Research Paper

The survival successes of mycorrhizal and non-mycorrhizal *Cotoneaster franchetti* Bois. under different climate and various growing media

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In the detailed planting applications of landscape architecture, the negativities created by insufficiencies in ecological conditions and care interferences create effects that increase economical losses. On the other hand, the drought in summer is an important problem. As a result, the plant development decreases, the nutrition relations are affected negatively, plants remain weak and they can not give the desired effect, while 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 purpose of this study was to research the survival successes of mycorrhizal and non-mycorrhizal plants in various environmental conditions and different breeding environments. For this purpose, mycorrhiza effects are experienced on *Cotoneaster franchetti* Bois. plants, which are preferred at landscape architecture designs because of their functional and esthetic characteristics. According to the obtained results, in groups where mycorrhiza application was made in different terrain conditions, the total dying *C. franchetti* Bois. plant percentage is 7.69, while the death percentage was 26.92 in the control group.

Key words: Mycorrhiza, *Cotoneaster franchetti* Bois., drought, plant growing.

INTRODUCTION

In landscape architecture growing medium conditions, if there is not enough rain and nutrition material in the soil, irrigation and organic material application is needed in order not to let the plant die and maintain the aesthetic beauty in planting studies. This situation also becomes significant for the places suffering from drought in summer period. Therefore, the growth of plants decreases, their nourishment relations are affected negatively, the plants remain weak and they do not give the demanded visual effect, while in some situations this can lead to death. As a result, they also loose their impact in the design. Plants can resist drought only with regular and sufficient care, watering and organic material additions. This reveals the work power loss and excess cost. In fields with these kinds of situations, mycorrhiza helps the plant to grow in a healthy way without going into stress.

Mycorrhiza is the most commonly known coexistence between 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 to absorb 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 increases the plants root surface area, therefore encourages the growth of plant roots for absorbing nutrients and water from soil. Along with that it 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, and in addition, it helps the roots at water and nutrient intake processes (Marschner and Dell, 1994; Azcon et al., 1996; Davies, 2000).

The most common mycorrhiza in nature is Endomycorrhiza, which is known as Vesicular-Arbiscular Mycorrhiza (VAM) (Harley, 1989; Powell and Bagyaraj, 1984; Bonfante-Fasolo, 1984). It is estimated that they exist in about 85 to 90% of angiosperms, especially in the roots of flowering plants (Harley and Harley,1987; Mukerji

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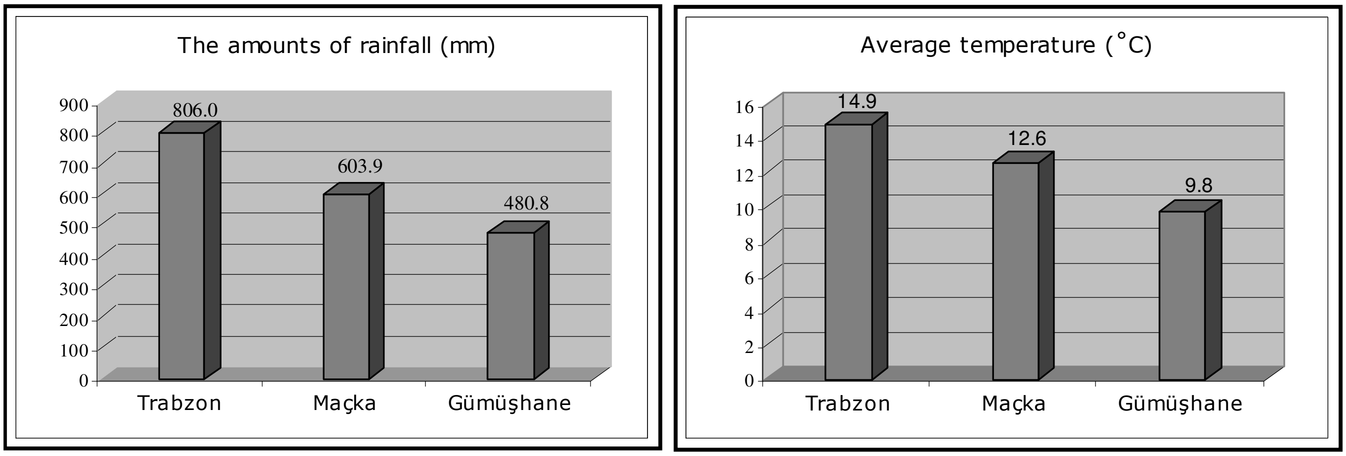

Figure 1. Annual mean precipitation and temperature of the study area.

et al., 2000).

The aim of this study was to determine the effect of mycorrhiza in landscape arrangement detailed planting on plants in rural and urban areas where conditions are tough. For this purpose, a research was done on whether or not the usage of mycorrhizal plants may minimize the problems in planting studies, especially in drought areas. In order to realize the aim of this study, the effects of mycorrhiza on survival rates of *Cotoneaster franchetti* Bois. plant, which is a preferred plant in landscape architecture vegetation applications, due to its functional and esthetic characteristics, were investigated.

MATERIALS AND METHODS

Biological material and growing conditions

In this study, 2 years old plants of *C. franchetti* Bois., which were grown in polyethylene tube of 2lt capacity, were used and 3 different planting media were prepared. For sterilization purposes against root infections, these media were left in autoclave under 121°C and 2 atmosphere pressure for 1 h (Matsubara et al., 2000). The prepared media are:

1. Soil (S).
2. Soil + river sand (1:1) (SS).
3. Soil + river sand + organic matter (3:6:1) (SSO).
4. Soil + sterilization (Ss).
5. Soil + river sand (1:1) + sterilization (SSs).
6. Soil + river sand + organic matter (3:6:1) + sterilization (SSOs).

In greenhouse, the plants were planted in polyethylene tubes separately and 4 g of mycorrhizal was inoculated for each plant. The plants were also placed in these media without inoculation (control groups). *Glomus mosseae* was used as mycorrhiza species in the study, whereas the mycorrhiza material was obtained from Idemitsu Kosan Company in Japan. After mycorrhiza inoculation procedure, 500 mg N (nitrogen) and 200 mg K (potassium) was applied to each 2lt tube. As a result, ammonium sulfate, triple super phosphate and potassium sulfate were used as fertilizer sources. The plants were watered twice every week in a such way that the same amount of water (~200 ml) was supplied to each tube. Also, savage grasses were removed from the media mechanically during the study. In the greenhouse stage, mycorrhiza was inoculated to 6 different media and the non-inoculated controls, *C. franchetti* Bois. plants, were planted in the application areas after 6 months. The plants were removed from the tubes and planted with their root surrounding media in the application areas (Trabzon, Macka and 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 amounts of rainfall of the averages in the application areas in Trabzon, Macka and Gumushane are given in Figure 1. Also, the average temperature values are given in Figure 1. The first area in the city center of Trabzon is at 40° 59' north latitude and 039° 46' east longitude with an average altitude of 179 m, the second area in Macka town of Trabzon is at 40° 48' north latitude and 039° 36' east longitude with an average altitude of 343 m, while the third area in Gumushane is at 40° 26' north latitude and 039° 30' east longitude with an average altitude of 1193 m.

The plants, which were inoculated with mycorrhiza in the greenhouse stage, were again subjected to mycorrhiza process in the application area. So, 2 g of mycorrhiza was placed in the planting hole before the plants were removed from their polyethylene tubes and planted. After the plants were planted in the application areas in May 2007, watering was done in 3 different regions in May and June once in every week, and June to August twice in every week. No watering was done in the 2007 fall and 2008 winter months, instead the plants were left in natural conditions. Special attention was given for the plants to take equal amounts of water (~700 ml) in each application area.

Measurements

During the application study in 3 different areas, observations were made to determine the effect of mycorrhiza and the control applications on the living situations of *C. franchetti* Bois. plants, and at the end of the study, dying plants were observed.

RESULTS

At the beginning of the application studies, 13 plants were planted in each medium in three different lands, while land application study was given a start with 468

Table 1. The survival percentages of *C. franchetti* Bois. plants in the research area.

Area	Medium	At the end of the study			
		The number of living plants		The number of dead plants	
		Mycorrhiza +	Mycorrhiza -	Mycorrhiza +	Mycorrhiza -
Gumushane	S	9	13	4	0
	Ss	11	4	2	9
	SS	12	12	1	1
	SSs	11	4	2	9
	SSO	13	11	0	2
	SSOs	12	9	1	4
Total		**68**	**53**	**10**	**25**
Macka	S	13	12	0	1
	Ss	13	13	0	0
	SS	13	11	0	2
	SSs	8	0	5	13
	SSO	13	9	0	4
	SSOs	11	8	2	5
Total		**71**	**53**	**7**	**25**
Trabzon	S	12	12	1	1
	Ss	13	13	0	0
	SS	13	12	0	1
	SSs	13	4	0	9
	SSO	13	13	0	0
	SSOs	13	11	0	2
Total		**77**	**65**	**1**	**13**
Grand Total		**216**	**171**	**18**	**63**

The number of planted *Cotoneaster franchetti* Boiss. was 13 in each site and media
S: Soil, Ss: Sterilized Soil, SS: Soil+Sand, SSs: Sterilized Soil+Sand, SSO: Soil+Sand+Organic Matter, SSOs: Sterilized Soil+Sand+Organic Matter

C. franchetti Bois. plants. The survival rates of *C. franchetti* Bois. plants at the beginning and end of the application studies are given in Table 1.

In the study made with *C. franchetti* Bois. plants, it was detected that among the plants to which mycorrhiza inoculation was applied, most losses were observed in S media in Gumushane application area and SSs media in Macka application area. In Trabzon application area, a single plant death was observed only in S media; whereas in SSs media of Macka application area, all plants to which mycorrhiza inoculation was not applied died. Besides, other serious losses were observed in Gumushane Ss, SSs and Trabzon SSs medium.

At *C. franchetti* Bois. plants, the quantity of the dying plant to which mycorrhiza inoculation was applied, was 18 at the end of the study and 63 in the non-mycorrhizal group. In Gumushane, Macka and Trabzon application areas, when the percentage of dying plants were examined, it was understood that the dying percentage of control plants in the area was much higher than the mycorrhizal plants. It was also determined that the dying plant percentage in Gumushane and Macka application areas was higher than Trabzon application area (Figure 2).

When the living percentages of *C. franchetti* Bois. plants in different application areas and different growing media were examined, it was observed that the living percentages of plants in Gumushane application area Ss, SSs, SSO and SSOs medium, to which mycorrhiza was applied was higher than the plants to which mycorrhiza was not applied. Particularly, the living percentages in Ss and SSs were very low (30.8%). Among the application areas, it was only in Gumushane area S media that the living percentages of control *C. franchetti* Bois. plants were found to be higher than the mycorrhizal plants (Figure 3). In Macka application area Ss media, it was observed that there were no losses, and the living percentages were same in the mycorrhizal and non-mycorrhizal plants. In SSs media, the living percentage of

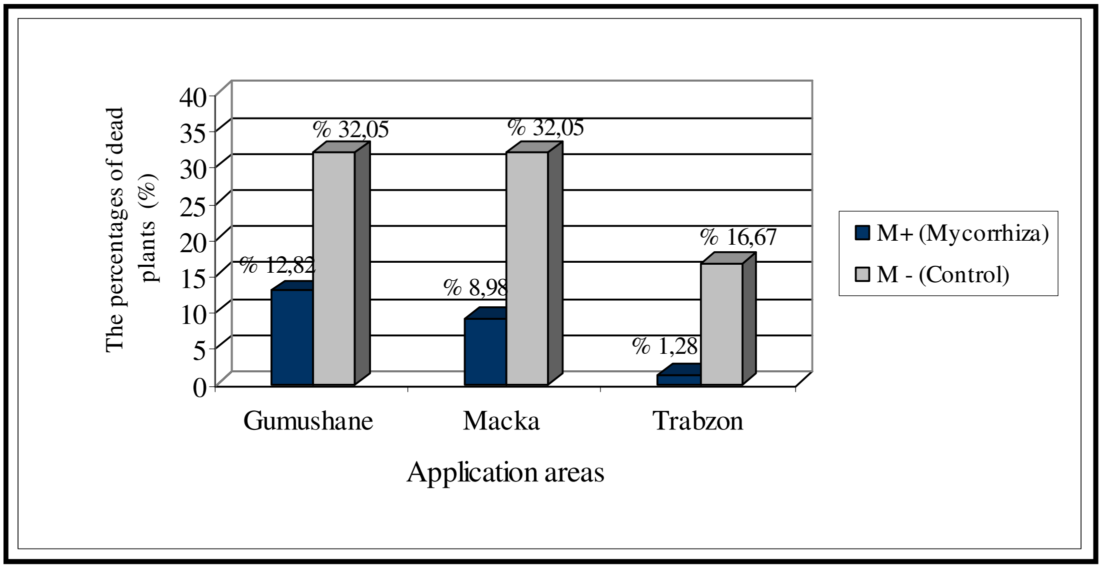

Figure 2. The percentages of dead *C. franchetti* Bois. plants at the end of the study.

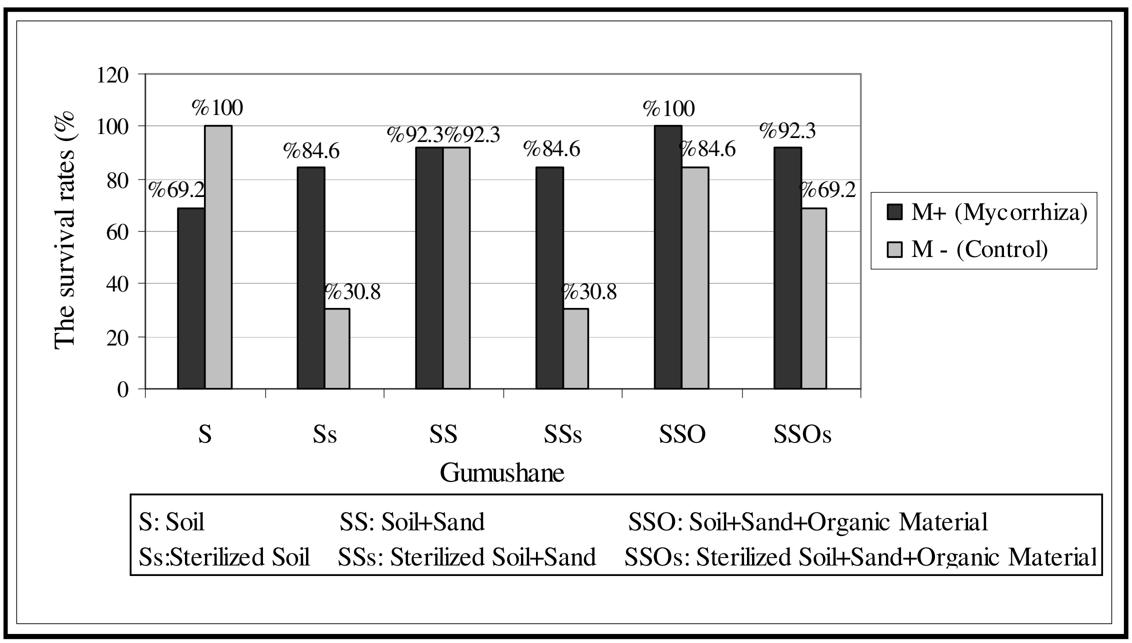

Figure 3. The survival percentages of *C. franchett* Bois. plants in different media in the application areas of Gumushane.

mycorrhizal plants was 61.5%, while the living percentages of the control plants were 0%. On the other hand, in S, SS, SSO and SSOs media, the living percentages of mycorrhizal plants were detected to be higher than the control group (Figure 4). In Trabzon application area, while the living percentages were found to be equal in S, Ss and SSO media, the living percentages of mycorrhizal plants were detected to be higher in SS, SSs and SSOs media than in the control group. Particularly, the difference between the two groups was observed to be very significant in SSs media (Figure 5).

DISCUSSION

The dying plants in application areas could not bear the hot weather conditions after 2007 June (first observation

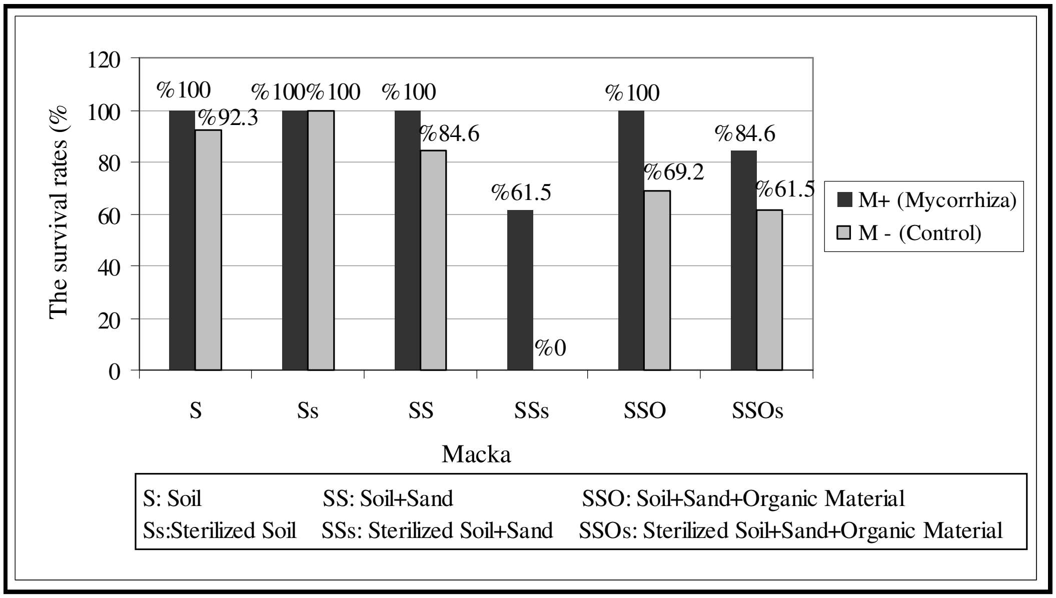

Figure 4. The survival percentages of *C. franchetti* Bois. plants in different media in the application areas of Macka.

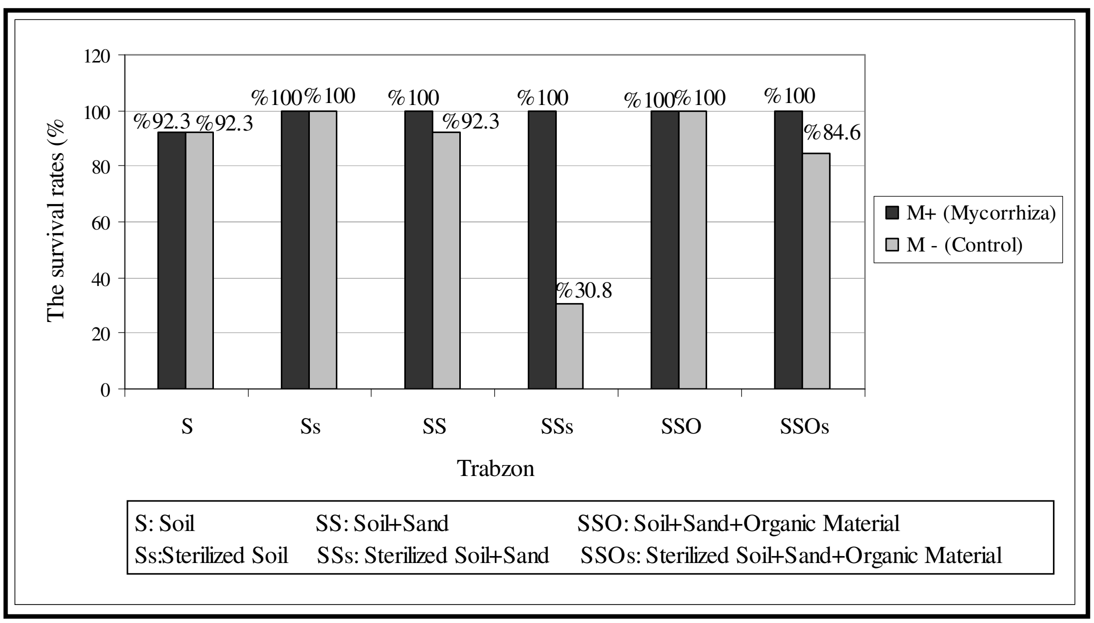

Figure 5. The survival percentages of *C. franchetti* Bois. plants in the application areas of Trabzon.

period) and as such, were dried to death. The climate data of the application areas showed that 2007 July and August were the months when the highest temperature and lowest rain was observed throughout the study. It was determined that the dying plants mainly belong to the group where mycorrhiza was applied. Therefore, it was understood that mycorrhiza application increased the resistance of plants to the dry conditions of summer months. Today, water shortage and drought especially has become a problem in summer months. Nevertheless, mycorrhiza application under these negative conditions can minimize plant losses. When Gumushane, Macka and Trabzon application areas were generally examined, the loss percentages of mycorrhizal *C. franchetti* Bois. plants were lower than the control group. It was determined that mycorrhizal plants struggled better with dry conditions and had a higher survival capability when compared with non-mycorrhizal plants. Also, it was determined that the total dying mycorrhizal *C. franchetti* Bois. plant percentage was 7.69%, while the death percentage was 26.92% in the control group. In the study, which was on *Helianthemum almeriense*, to which drought stress was applied, it was found that the living percentage of plants with mycorrhiza was 50% higher (Morte et al., 2000). Thus, mycorrhiza increased the resistance of plants and decreased plant deaths.

In Gumushane application field, the total rain amount was the lowest and the average temperature value was the highest in mycorrhizal plant in soil + river sand + organic material (SSO) media (3:6:1). Consequently, the organic material encouraged mycorrhiza and provided a healthy plant development. Under the same conditions, in a study which was done by using *Forsythia x intermedia* plant, it was observed that mycorrhiza was effective on plant development, while plant deaths in mycorrhizal plant group was lower than the control group. So, mycorrhiza affected the development of the plants under drought stress positively and provided a more resistant and healthy development for them (Pulatkan, 2010). The study of Calvet et al. (2001) on *Prunus persica* and the study of Carpio (2002) on *Ipomea carbea* sups*. fistulasa* showed that the growth of the plants that were inoculated with different types of mycorrhiza was better than the plants that were not inoculated with mycorrhiza.

Mycorrhiza plays 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 discover the effect of mycorrhiza on the rotting disease in roots, it is stated that mycorrhiza inoculation has a positive effect on the rotting problem of *Asparagus officinalis* L. plants and it reduces the plant deaths to a minimum (Matsubara et al., 2000, 2001).

Conclusions

As a result of this study, it was found that mycorrhiza application was extremely useful for plants especially in the regions with low rainfall values and drought problems. In these media, since mycorrhiza helps the development of plant by colonization increment, organic material addition seems to be beneficial. In order to gain successful results in vegetation studies, mycorrhiza and organic materials should be used during planting.

In planting studies that will be made by usage of mycorrhizal plants, it is possible to provide sustainability of the plantings by increasing the holding success of the plants, decreasing the irrigation costs and providing maintenance during planting stage and in the following years. As a result, usage of mycorrhizal plants that will develop better in landscape applications will ease success both in functional and aesthetic means. Particularly, in dry areas where maintenance possibility is low and water sources are tight, the plant with mycorrhiza inoculation will be able to survive in spite of the negative conditions. On the other hand, the plant will have a good form, in that it will increase the visual quality and aesthetic value, and will be able to give the desired effect in planting designs.

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