The Effects of Five Avocado Rootstocks on Seedling Properties of Commercial Avocado Cultivars

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Abstract: In this study, results of which have been presented, our aim is to determine avocado commercial cultivars grown in Antalya- Turkey ecological conditions and their graft compatibity with *Persea americana* var. *drymifolia* and *P. nubigena* var. *guatemolensis* avocado rootstocks. In the research as experimental material Topa Topa, Blace, Mexicola, W1 and W2 rootstocks together with Hass, Fuerte, Zutano and Bacon commercial avocado cultivars have been used. The study was conducted between 2006-2007 in BATEM. The results of the experiment have shown that rootstocks were statistically significant in the graft survival rate (%), rootstock diameter (cm), scion diameter (cm), shoot length (cm) and in terms of properties, and the best results could be achived from plants which are Fuerte avocado cultivar grafted on Topa Topa rootstock.

Keyworlds: Avocado, grafting, scion/rootstock combination, survival rate, Fuerte, Topa Topa.

Indroduction

Avocado is an important fruit species, belonging to Lauracea family, which is evergreen and economicaly significant (Zentmyer, 1987). Today avocado is being cultivated in nearly 50 countries in the world. The first rank of avocado production and trade belongs to countries such as Mexico, USA, Brezil, Dominic Republic and South Africa. World avocado production, as of 2007, has been realized in 3.2 million tons (FAO, 2007). These countries are relatively far from North European countries where avocado is consumed extensively. Turkey, due to its geographical and ecological conditions, has plays a significant role in avocado production and exportation.

Particularly the Mediterrenean Region of Turkey, because of the fact that it supplies special temperature avocado requires is the most important province in growing this species. There is a 400-ton avocado production in Turkey all of which is being realized in Antalya, Hatay and Mersin, all situated in the Mediterrenean region.

In order to investigate avocado growing facilities in our country, initial studies in early 1970's started via our Institute by introducing the four important commercial avocado cultivars from California. Through this study and those in forthcoming years, the yield which is to show various cultivars of the Mediterrenean region in different locations will depict the fruit quality, the harvest time, adaptation to climate, have been examined, and relative varieties have been selected (Dogrular et al., 1983, Demirkol 1998, Bayram and Aşkın, 2006).

Nevertheless, growing of avocado fruit, which was introduced in Turkey in the 1970's, has not reached the required level as yet. At present, there is an avocado production of 400 tons in our country, particularly in the Mediterrenean region.

In fruit culture, grafting of different scions and rootstocks has been a traditional practise with the aim to confer dwarfing characteristics and resistance to environmental stress like salinity, cold, drought, pests and diseases. The new charecteristics obtained in the plant must be the result of an intense interaction between the rootstock and scion carrying different genetic information (Reyes-Santamaria et all. 2002, Mickelbart1 and Arpaia, 2002, Krezdorn, 1973).

Commercial avocado trees are propagated by grafting of budding scions of desirable cultivars onto seedling or grafted rootstocks. Avocados can be grown from seeds, but fruit quality and yield potential will be quite variable. Grafted on budded avokado trees usually produce fruits when three to five years old, while seedlings often require five to seven years.

Originating in the tropics, the avocado is very sensitive to climatic factors prevailing in the subtropics, especially drought and extreme temperatures. Extreme temperatures result in low productivity and sometimes even in severe damage to the tree canopy (Bergh 1976; Oppenheimer 1978). Avocado is also sensitive to soil stress and salinity. A very common soil stress factor is root rot disease, caused by the fungus *Phytophthora cinnamomi*, which is usually associated with lack of aeration (Ben-Ya'acov and Michelson, 1995). In certain years, due to this disease factor in avocado orchard in California, it has been stated that asmuch as 20% tree loss took place. In avocado growing, there is no resistant to this disease in tropical and subtropical climate zones. However by using grafting tecniques, it is possible to reduce loss resulting from this disease factor.

The main climatic factor affecting avocado production in the cooler subtropics is low temperatures. Indeed, avocado is extremly sensitive to cold, especially in the blooming period. Furthermore, chilling problems associated with avocado growing in the subtropics such as Turkey do occur. Commercial avocado cultivars are more sensitive to cold temperature than rootstocks. Grafting is a widely used technique in avocado growing regions namely Turkey, Israel and Spain, for rootstocks are resistant to cold. Therefore, some rootstocks belonging to Mexican race, which is widely used in grafting, are more resistant to cold than others.

Referring to the requirements mentioned above, the objective of this study, results of which have been presented, was to evaluate the rootstock potential of avocado cultivars, 'Topa Topa', 'Blace', 'Mexicola', 'W1' and 'W2' for commercial avocado cultivars.

Material and Methods

This study was conducted between the years 2006-2007 in a nursery situated in West Mediterrenean Agricultural Research Institute in Antalya-Turkey (36^0 52 N', 30^0 43' E).

In this study, five Mexican rootstocks (Topa Topa', 'Blace', 'Mexicola', 'W1' and 'W2' were evaluated as rootstocks.Hass (belonging to Guatemale race), Zutano (belonging to Mexican race), Bacon and Fuerte (MexiconxGuatemala hybrids) were used as scions. By the time rootstocks levelled to 75 cm on May 2nd 2007, scions were grafted onto rootstocks with Whip&Tongue Grafting. On July 20th 2007, graft tie was untied; graft survival rate (%), rootstock diameter (cm), scion diameter (cm) and shoot length (cm; distance between graft point and the top of shoot) were measured.

All grafting groups were laid out with three replications and 10 plants in each replicants in the randomised block experimental design. Data were subject to analysis of variance by SAS statistical program (SAS Institute, Version 7) and means were compared by LSD's (Least Significant Differences) test at 0.05 significance levels.

Results

1. The Effects of Different Rootstocks on Graft Survival Rate (%)

The effects of different rootstocks on graft survival rate (%) is shown in Table 1. Results reveal that the effects of rootstocks on graft survival rate (%) are statisticaly significant (Table 1). According to reciprocal interaction between rootstocka and cultivars, it can be observed that graft survival rate is directly associated with, rootstocks and cultivars and their reciprocal interaction, at main effect level. At rootstock level, the highest graft survival rates that have been found out and fixed were 92.7 % in TTS rootstocks; the lowest graft survival rate 83.38 % in Y2 rootstock . When graft survival rates of cultivars are evaluated, on the otherhand, the highest graft survival rate of 96.67 % was determined in Fuerte cultivar.This cultivar is followed by Bacon (90.83) and Zutano (84.17 %) cultivar. Consequently, in terms of graft survival rate, however, the lowest graft survival rate of 83.34 % has been determined in Hass cultivar. Upon examination of data in Table 1.it can be seen that at reciprocal interaction level, Fuerte onto which TTS and Mexicola rootstock were grafted with a highest 100% graft survival rate was found. These differences, most probably resulting from ecological conditions, maintanence and the differences between cultural practices that are applied. Nonetheless, results clearly indicate rootstocks have affected graft survival rates and in the defined experiment conditions, the best results have been achieved from plants grafted onto TTS rootstocks.

Table 1. Effect of rootstocks on the graft survival rate (%)

	Cultivar				**Mean Rootstock**
Rootstock	Hass	Fuerte	Zutano	Bacon	
Y1	79.17 Ed	91.67 Cc	79.17 Ed	95.83 Bb	**86.46 D**
Y2	79.17 Ed	95.83 Bb	70.83 Ed	91.67 Cc	**84.38 E**
TTS	91.67 Cc	**100.00 Aa**	91.67 Cc	87.50 Dd	**92.71 A**
Blace	87.50 Dd	95.83 Bb	87.50 Dd	87.50 Dd	**89.58 C**
Mexicola	79.17 Ed	**100.00 Aa**	91.67 Cc	91.67 Cc	**90.63 B**
Çeşit Ort	**83.34 d**	**96.67 a**	**84.17 c**	**90.83 b**	
$LSD_{\%5}$ A*, $LSD_{\%5}$ Ç*, $LSD_{\%5}$ AxÇ*					

*: significant ($p \leq 0.05$)
Means followed by the same letters within each cultivar are not significantly different according to $LSD_{0,05}$.

2. The Effects of Different Rootstocks on Shoot Length (cm)

Table 2. shows the effects of different rootstocks on shoot length (cm). Looking into shoot length and statistical analyses , it can be seen that rootstock and cultivar reciprocal interaction between rootstock and cultivar are significantly effective. The highest shoot length of 29.24 cm on rootstock level has been obtained from plants gtafted onto TTS rootstock. The lowest value, however, is observed in plants grafted onto W2 rootstock. The shoot length in this group has been fixed as 18.60 cm (Table 2.). In statistical analyses' amount varieties, the highest shoot length of 28.27 cm with Fuerte; the lowest value of 16.62 cm with Bacon has been recorded (Table 2). At rootstock x cultivar reciprocal interaction level, the highest shoot length value of 36.55 cm has been obtained from Fuerte plants grafted onto TTS rootstock.

Table 2. Effects of rootstocks on the shoot lenght (cm)

	Cultivar				Mean Rootstock
Rootstock	Hass	Fuerte	Zutano	Bacon	
Y1	18.33 Dd	25.32 Ba	26.37 Aa	15.31 Dd	**21.33 C**
Y2	21.96 BCd	22.84 BCc	17.67 Dd	11.92 Dd	**18.60 D**
TTS	29.28 Aa	36.55 Aa	29.97 Aa	21.14 Cd	**29.24 A**
Blace	23.97 Bb	27.81 Ba	35.38 Aa	16.56 Dd	**25.93 B**
Mexicola	23.32 Bb	28.82 Aa	30.44 Aa	18.18 Dd	**25.19 B**
Mean Cultivar	**23.37 c**	**28.27 a**	**27.97 b**	**16.62 d**	
$LSD_{\%5}$ A*, $LSD_{\%5}$ Ç*, $LSD_{\%5}$ AxÇ*					

*: significant ($p \leq 0.05$)
Means followed by the same letters within each cultivar are not significantly different according to $LSD_{0,05}$.

3. The Effects of Different Rootstocks on Rootstock Diameter (mm)

Data concerning effects of different rootstocks on rootstock diameter and their statistical evaluations have been presented in Table 3. It has been determined that rootstock diameter indicates different values according to reciprocal interaction. Upon being evaluated in terms of rootstock, the highest data with rootstock diameter of 9.39 mm has been measured in plants grafted onto W2 rootstock (Table 3). On the otherhand, when data in Table 3. are to be examined at cultivar level, the highest rootstock diameter of 9.32 cm with Zutano cultivar; the lowest rootstock diameter of 8.73 mm at Fuerte cultivar have been found out and fixed. When all rootstock and cultivars are assesed, the highest rootstock diameter of 9.99 cm has been fixed with Zutano grafted onto W1 rootstock.

Table 3. Effects of rootstocks on the rootstock diameter (mm)

	Cultivar				Mean Rootstock
Rootstock	Hass	Fuerte	Zutano	Bacon	
Y1	8.65 BCc	9.55 Aa	9.99 Aa	9.17 Aa	**9.34 A**
Y2	9.88 Aa	8.84 ABb	9.53 Aa	9.32 Aa	**9.39 A**
TTS	8.84 ABb	8.13 Cc	9.03 Aa	8.54 Cc	**8.64 C**
Blace	8.93 Bb	8.51 Cc	9.10 Aa	8.87 Bb	**8.85 B**
Mexicola	9.20 Aa	8.63 Cc	8.94 ABb	9.09 Aa	**8.97 AB**
Mean Cultivar	**9.10 a**	**8.73 bc**	**9.32 a**	**8.99 ab**	
$LSD_{\%5}$ A*, $LSD_{\%5}$ Ç*, $LSD_{\%5}$ AxÇ*					

*: significant ($p \leq 0.05$)
Means followed by the same letters within each cultivar are not significantly different according to $LSD_{0,05}$.

4. The Effects of Different Rootstocks on Scion Diameter mcm)

Data related to effects of different rootstock on scion diameter have been presented in Table 4. Upon examining scion diameter values and their statistical evaluations,it can be stated that rootstocks, cultivars and the reciprocal interaction of these two factors have considerable impact on scion diameter. At rootstock level, the highest scion diameter value of 5.93 mm has been obtained from plants grafted onto W2 rootstock, while the lowest value of 18.60 mm has been found in plants grafted onto W2 rootstock (Table 4.). Statistical analyses between cultivars have been recorded as of the highest scion diameter being 5.99 mm in Bacon cultivar; the lowest scion diameter being 5.29 mm with Zutano cultivar (Table 4.).

Table 4. Effects of rootstocks on the scion diameter (mm)

	Cultivar				Mean Rootstock
Rootstock	Hass	Fuerte	Zutano	Bacon	
Y1	5.62 Cb	5.56 Cbc	5.81 Aa	6.02 Aa	**5.75 B**
Y2	6.43 Aa	5.33 Cc	4.75 Cc	5.81 Aa	**5.58 C**
TTS	5.66 Bb	6.50 Aa	5.16 Cc	6.41 Aa	**5.93 A**
Blace	5.71 Ba	5.56 Cbc	5.53 Cc	5.70 Ba	**5.63 BC**
Mexicola	6.17 Aa	5.40 Cc	5.21 Cc	5.99 Aa	**5.69 B**
Mean Cultivar	**5.92 a**	**5.67 b**	**5.29 c**	**5.99 a**	
$LSD_{\%5}$ A*, $LSD_{\%5}$ Ç*, $LSD_{\%5}$ AxÇ*					

*: significant ($p \leq 0.05$)
Means followed by the same letters within each cultivar are not significantly different according to $LSD_{0,05}$.

Discussion and Conclusion

In the previous studies concerning avocado rootstock and cultivar inter relations, the yield has been emphasized and assesments in graft survival rate in these sources have been mentioned to a certain extent.

Research findings reveal that plants grafted onto different rootstocks vary in terms of graft survival rate, scion diameter,rootstock diameter and shoot length. Nevertheless, in Fuerte cultivar the highest graft survival rate (%) has been fixed in plants grafted onto Mexicola rootstock. Similar results show similarities between findings by Ben-Ya'acov A. and Esther Michelson (1995) who researchs on effect of different rootstock on graft survival rate that were previously presented in Fuerte and Hass avocado cultivars. These researchers, in their studies, have obtained the highest graft survival rate of 90 % from plants grafted onto Mexicola rootstock To put it in general terms, as a result of such studies, it can be stated that the Fuerte cultivar grafted onto TTS rootstock seems to be the best rootstock, scion combination, in the light of all findings.

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