

Determination of the Development Performances of Pecan Saplings in Aydin ecological Conditions

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Authors' contributions

This work was carried out in collaboration among all authors. Author OD designed the study, managed the literature searches and wrote the protocol and the first draft of the manuscript. Authors OD, FET and SB managed the analyses of the study. Author TK performed the statistical analysis. All authors read and approved the final manuscript.

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ABSTRACT

In this research, the sapling growth performances of Pecan cultivation in Aydin ecological conditions were investigated. "Burkett" Pecan rootstock and "Mahan14", "Wichita7" and "Choctaw2" pecan cultivars were used. Starting from the date of planting; Sapling stem diameters were measured 5 cm above the graft site. Diameters of rootstocks was measured 5 cm below the graft site, bud burst dates are determined (min %70 of buds), shoot diameters were measured at 15-day intervals from the place after the first two buds. Shoot lengths were measured at 15-day intervals. The measurements were carried out for 2 consecutive years. Repeated Measures Anova is used to determine whether there are significant differences in the data. The development difference between cultivars in both regions was investigated. In the analysis, averages of five replicate measurements in two years and 12 different periods. Pecan saplings showed a good development in the ecological conditions of Aydin (37°45' 0"N - 28°0'0"E). These results show that

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in the province of Aydın, Pecan cultivation can be done except in very cold and very dry places. However, the study should be supported by future fruit productivity studies. The present research findings will be useful for regions with similar climatic conditions.

Keywords: Pecan growing; sapling growth; Wichita7; Choctaw2; Mahan14.

1. INTRODUCTION

Pecan, which is one of the hard-shelled fruit species, (*Carya illinoensis* (Wangenh.) K. Koch) is produced and demanded especially in America and Mexico, which is a natural spreading area. Pecan seeds were first brought in 1953 and has been produced in Turkey. However, the main works for production started in 1969 [1].

Pecan nuts have a very high nutritional value in terms of carbohydrates, proteins, vitamins and fat, and is used in the production of nuts, bakery products, confectionery products and oil. It is rich in oleic acid and natural antioxidants, which has an important role in the prevention of vascular health and heart diseases. In 100 grams of pecan nuts, there are 3.4% water, 687 cal., 9.2 g protein, 71.2 g fat, 14.6 g, carbohydrate, 130 I.U. Vitamin A, 289 mg P, 603 mg K [2,3]. It is very preferred because its thin shell and inner part can be easily and completely removed. Although it is generally known as a type of fruit that can grow in subtropic climatic conditions, it can also grow in relatively cold and dry conditions [4].

Short and not very hard winter, long hot summers, late and early frosts are rarely seen, in most of the development season, places where the air humidity is below 55% and altitude up to 150-200 meters is suitable for Pecan growing. In unsuitable environmental conditions, there are problems in flowering and fruit set, and the fruits cannot fill in completely.

On the other hand, it is reported that trees can develop even though they do not bear fruit in unsuitable places. Pecan nuts can easily grow at altitudes up to 200 meters at sea level. In order for the trees to develop well, it needs a warm and rainy winter period and a long and hot summer period. Since the pile has a rooted and strong root system, it is a type of tree that can benefit from the water deep in the soil. However, since the pile root is broken during the removal of the saplings, it loses its feature relatively and requires sufficient water in the soil during fruit development and for this reason irrigation is important to have enough water in the upper parts of the soil in arid years. It shows rapid and

good development in fertile and deep soils with sufficient water [5,6,7].

Pecan is a upright and fast growing tree species and can be used as an ornamental tree in landscape arrangements and as a forest tree in afforestation activities. Its timber is valuable because its body grows properly and its wood is durable. Therefore, additional income can be obtained by timber of aged trees. Pecan nuts require less workmanship in terms of cultural practices such as care, pruning and harvesting compared to other fruit types. Production costs are relatively low which has a positive effect on the income of the producers [4,8,9,10].

Because of the different climate conditions, Turkey is one of the rare countries where cultivation of many types of fruit. As in all countries of the world, the propagation and production of new and different fruit types and cultivars are tried in Turkey, among them, those that attract the attention of the consumers and have economic importance are rapidly spreading. However, one of the most important factors limiting production is the ecological demands of fruit species. For this reason, it is important to identify fruit cultivars suitable for environmental conditions [11,12].

In the Aydın province where the Mediterranean climate is dominant in terms of climate and vegetation, summers are hot and dry, winters are warm and rainy. Great Meanderes Valley, like other Aegean plains, is a groove opening to the sea from the west shaped. For this reason, the warming effect of the sea and the winds that bring precipitation penetrate the innermost parts. It is cooler than the Mediterranean region due to the northern winds (Anonymous, Climate conditions of Aydın province[13].

In terms of its climate and soil characteristics, the province of Aydın is considered to be quite suitable for Pecan cultivation. More development of fruit growing, introduction of alternative fruit types and providing new income for producers are important for our region and all around the world. Besides making a very important contribution to the economy of the region in

terms of fruit growing, the use of Pecan in landscape arrangements and afforestation activities is another important issue.

In this research, sapling growth performances which are the first stage of Pecan cultivation in Aydın ecological conditions were investigated.

2. MATERIALS AND METHODS

2.1 Materials

In this study; "Burkett" Pecan rootstock and "Mahan14", "Wichita7" and "Choctaw2" pecan cultivars were used. Saplings with bag were supplied by the Western Mediterranean Agricultural Research Institute (BATEM).

Mahan is the most grown Pecan cultivar in our country due to the size of its fruit. It was very preferred in the first years in our country, however, it is not preferred today for reasons such as the fact that its very long and large fruits do not fill completely and the rate of non-filling in the fruit increases with the onset of aging.

It shows high periodicity. There is 700-750 hours of chilling request. It is necessary plenty of sun, water and fruit dilution for filling nuts. Fruit (nut) internal efficiency is 52%. The nuts separate from the shell very easily. In the later stages of development, due to the fact that the trees are quite elongated, it is difficult to dilute the fruit and the fruit internal efficiency decreases during the ripening period when the fruit weight increases. During the winter rest period when the leaf fall starts, the bud burst and bloom become irregular in the spring where the need for chilling cannot be met due to the hot weather and the yield and quality decrease accordingly [14].

Wichita variety is one of the most productive and early Pecan cultivar obtained by crossbreeding Halbert and Mahan varieties. It is a dark green leaf and very fast growing variety. Fruits (nuts) are very high quality and this quality is continuous. Fruit formation is seen in medium size and in the form of a cluster. Sometimes 8-9 fruits are seen together. There are about 132 walnuts in Kg. Fruits are an average of 7.8 g. Fruit internal efficiency is 58%. In our country, it can be grown in a region from south Marmara to Southeast Anatolia. There are 600-650 hours of chilling request. Wichita is somewhat susceptible to diseases and is a late harvest variety. Therefore, the coastal Aegean, Mediterranean and Southeastern regions are ideal areas with no

risk and long vegetation period. It is not preferred in very humid areas as it has fungal diseases. Due to its early ripening fruits, it attracts attention in suitable ecologies, therefore its commercial production has become widespread [5,14].

Choctaw is a Pecan cultivar obtained by crossbreeding Mahan and Success cultivars. It is a very productive cultivar and has large and attractive fruits. Its shell is thin and the internal efficiency is around 58-65%, it has brightly colored and delicious fruits, the request for chilling is 400-450 hours, Trees grow upright. It is suitable for the coastal regions of the Mediterranean and Aegean regions where the vegetation period is long, so that the nuts which are the consumed part of the fruit can fill inside [14].

The research was carried out in Aydın and Antalya provinces in order to compare the performances of Pecan cultivars in different climatic conditions and to compare their performance in different climatic conditions. Saplings grown in Antalya and known to adapt to this region were evaluated as control.

Aydın (37°45' 0"N - 28° 0' 0"E) province is mild and relatively rainy in winter, hot and dry in summer. Antalya (36°53'48.8"N - 30°42'53.4"E) is mild and very rainy in the winter, hot and humid in the summer. Since Pecan saplings are sensitive to the planting type and environmental conditions serious losses can occur after planting. Therefore, the development of the saplings in the first years indicates whether they are suitable for the region. For this reason, the part of the research where the sapling measurements are made is planned as 2 years. The data obtained at the end of the first and second years were subjected to statistical evaluations.

2.2 Methods

Starting from the date of planting in the first size standard saplings planted in Sultanhisar Vocational School and BATEM production / research gardens;

- Sapling stem diameters were measured 5 cm above the graft site. (electronic caliper, mm)
- Diameters of rootstocks was measured 5 cm below the graft site
- Bud burst dates are determined (min %70 of buds)

- Shoot diameters were measured at 15-day intervals from the place after the first two buds (electronic caliper, mm)
- Shoot lengths were measured at 15-day intervals. (tape measure, cm) (Kaplankiran et al. 2003).

The measurements were carried out for 2 consecutive years. The saplings were planted at 2x2 m distances to the land, sapling pits were opened with auger measuring 70x70 cm.

At the time of planting, each saplings were fertilized with 10 kg of organic manure and 1 kilo of N: P: K 3:15 compound fertilizer and fertilization continued at monthly intervals. The data were analyzed statistically. According to the counts and measurements obtained, comparisons were made between saplings grown in regions with different climatic characteristics in terms of sapling development. Repeated Measures Anova is used to determine whether there are significant differences in the data. The development difference between cultivars in both regions was investigated. In the analysis, averages of five replicate measurements in two years and 12 different periods belonging to three varieties from both regions were investigated and the differences between regions and varieties were investigated.

Measurements between regions and varieties are independent from each other. Measurements were taken in the same period in all varieties in both regions. No extreme values were found in the measurements, within-group distributions were normal.

3. RESULTS AND DISCUSSION

3.1 Shoot Length Developments

All cultivars show a relatively strong development in Antalya ecological conditions (Fig. 1). It was observed that the varieties that showed weak development in the first year in both regions showed a higher development in the second year. Compared to Antalya, it was observed that the varieties that showed relatively weak development in the Aydın in the first year accelerated their development in the second year. This is thought to be due to climate differences between the two regions. Antalya and its surroundings have more suitable conditions in terms of air temperature and especially in summer, in terms of air relative humidity. In Antalya and its surroundings, the relative humidity of the air is relatively high, but the air temperature is lower, whereas in Aydın and its surroundings, the relative humidity of the air is relatively low, but the temperatures are higher. In addition, the vegetation period in Antalya starts earlier and ends later, as the region is located to the south.

The growth rates of the varieties in both regions compared to the previous year are given in Fig. 2. As the reason for the stronger development in the second year may be attributed to the fact that the root systems of saplings do not fully develop in the first year and the saplings that form a strong root system in the second year begin to develop faster.

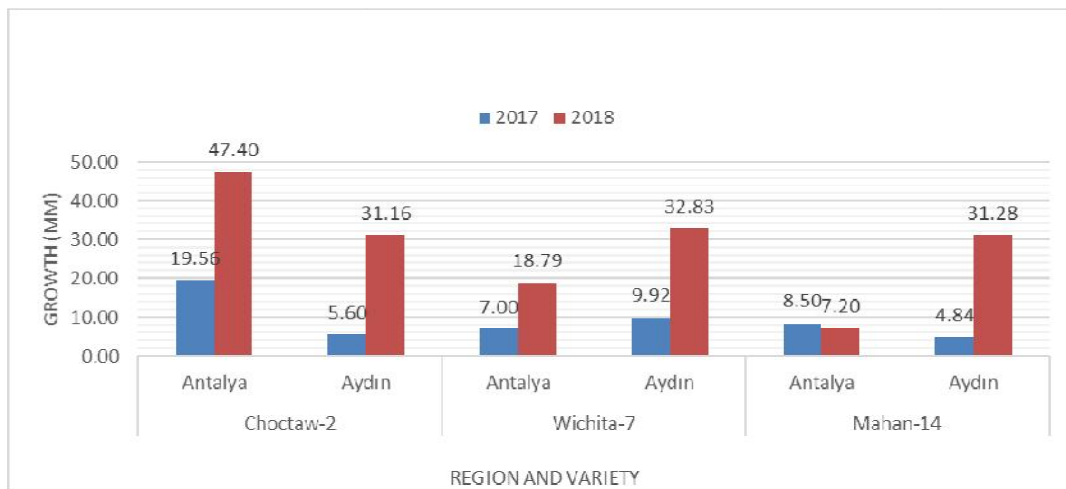


Fig. 1. Shoot growth of cultivars by years and regions (mm)
 The difference between repeated measurements is important ($F = 18.376$, $df = 22$, $P < 0.001$)

3.2 Shoot Diameter Developments

In Fig. 3, shoot diameter developments of the cultivars at Antalya and Aydin ecological conditions are given. In terms of shoot diameter development, a development similar to shoot length development is observed. In both regions, a relatively weak diameter development was observed in the first year, whereas in the second year it was observed that the shoot diameter development increased (Fig. 4). However, the shoot diameter development in Aydin conditions was less than the shoot diameter developments in Antalya ecological conditions. The highest shoot diameter development for the Aydin region was obtained from the Wichita variety, followed by Mahan and Choctaw varieties, respectively. However, in Aydin region, there was no

significant difference in shoot diameter development.

3.3 Rootstock diameter developments

The rootstock diameter development (cm) of the cultivars in different regions are given in Fig. 5. As seen in Fig. 5, the highest development in terms of rootstock diameter was obtained from Choctaw2 variety in both regions (Antalya / Aydin). Choctaw2 cultivar showed more rootstock diameters in Antalya and Aydin conditions than other varieties. On the other hand, although Mahan14 and Wichita7 varieties showed close growth in both Antalya and Aydin conditions, the rootstock diameter development of these two varieties is relatively higher than the Antalya conditions.

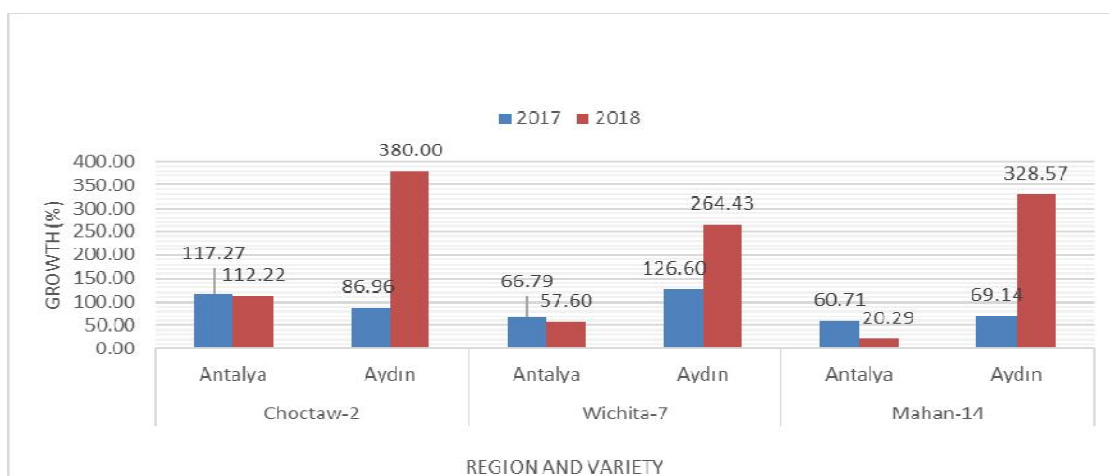


Fig. 2. Shoot growth rates of the cultivars in both regions compared to the previous year (%)
The difference between repeated measurements is important ($F = 18.376$, $df = 22$, $P < 0.001$)

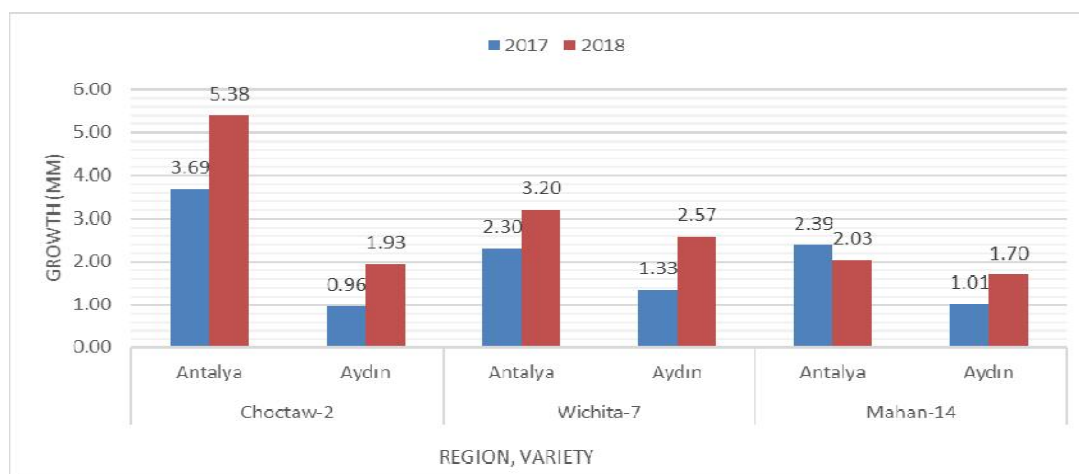


Fig. 3. Average shoot diameter development graphs of cultivars by years and regions (mm)
The difference between repeated measurements is important ($F = 17.063$, $df = 22$, $P < 0.001$)

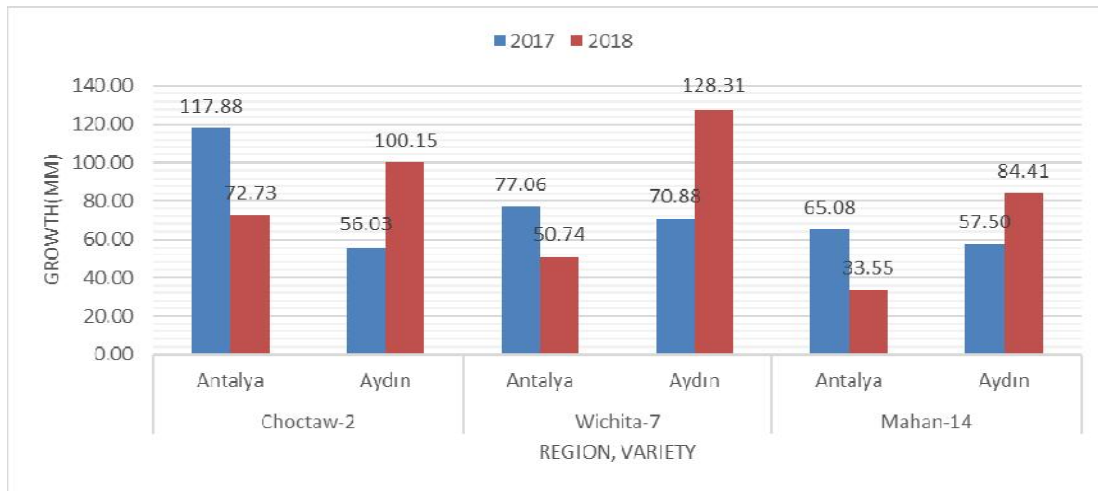


Fig. 4. Proportional shoot diameter growth rates of cultivars compared to the previous year (%)
The difference between repeated measurements is important ($F = 17.063$, $df = 22$, $P < 0.001$)

3.4 Variety Diameter Developments

The two-year average diameter developments of cultivars by regions are given in Fig.7. As can be seen in Fig. 7, Choctaw2 variety is the type with the highest diameter development in Antalya conditions, however, it has lagged behind Wichita7 and Mahan14 in Aydin conditions. Fig. 8 shows the diameter development rates of the varieties in two different regions according to the 2-year averages. There is a similar situation in terms of diameter development rates. Choctaw2 variety showed the highest proportional diameter development in Antalya conditions. In terms of diameter development rates, Wichita7 and Choctaw2 varieties has close diameter growth rates in Aydin conditions. Mahan14 type is relatively low.

3.5 Bud Awakening Dates by Region and Years

When the awakening dates of the cultivars in Antalya and Aydin conditions in 2017 and 2018 are examined, it is seen that all cultivars awoke on 21.04.2017 in Aydin conditions in 2017, while they were seen in Antalya conditions on 17.04.2017. In addition, it was observed that all saplings in Choctaw cultivar and 4 saplings in Wichita cultivar were awakened on 10.04.2107, while Mahan cultivar was the most awakened variety. It was observed that the time of waking up in 2017 was 2 weeks ago in Choctaw2 and Wichita7 varieties according to Aydin conditions in Antalya conditions.

In 2018, all cultivars were awakened on 03.04.2018 in the Antalya region, while the awakening of all the saplings in Aydin region was 2 weeks late on 28.04.2018 compared to the Antalya region. Looking at the awakening dates for both regions and years, it was observed that Mahan14 variety awoke later than Whichita7 and Choctaw2 varieties.

It is observed that all cultivars show a relatively strong development in the ecological conditions of Antalya. In both regions, the cultivars showing weak development in the first year showed a strong development in the second year.

It is also observed that the cultivars which showed relatively weak development in the first year in Aydin, increased their growth rate in 2. years. This situation is thought to result from climate differences between the two regions. Antalya and its surroundings have more suitable conditions in terms of air temperature, especially in summer relative air humidity.

In Antalya and its surroundings, the relative humidity in the summer is relatively high, but the temperature is lower, whereas in Aydin and its surroundings, the relative humidity in the summer is relatively low, but the temperatures are higher. In addition, the vegetation period in Antalya starts earlier and ends later, as the region is located to the South. For this reason, Pecan production started first in Antalya [1,3].

In both regions, the fact that the cultivars have more development compared to the previous

year may be attributed to the fact that the root systems of the saplings do not fully develop in the first year, and the saplings that form a strong root system in the second year begin to develop faster. The highest shoot development for the Aydın region was obtained from the Wichita2 cultivar, followed by Choctaw7 and Mahan14, respectively. However, there is no significant difference between the cultivars in Aydın ecological conditions in terms of shoot length development.

According to different researchers, places with short and not too harsh winter, long hot summers, late and early frosts are rarely seen, air proportional humidity is below 55% in most of the growing season and altitude up to 150-200

meters is suitable for Pecan growing. They reported that, in inappropriate environmental conditions, there were problems with flowering and fruit set and the fruits could not be filled completely. However, they reported that trees could thrive even if they did not bear fruit in inappropriate places. The results are in agreement with the literature. [5,6,7]. The study was carried out to determine the cultivation of Pecan in Aydın ecological conditions. For this purpose, it is aimed to determine the sapling development and adaptation, which is the first stage of fruit growing. The data obtained showed that although Pecan show relatively late waking compared to Antalya conditions, this delay does not have a significant effect on sapling development. Aydın and Antalya regions differ in

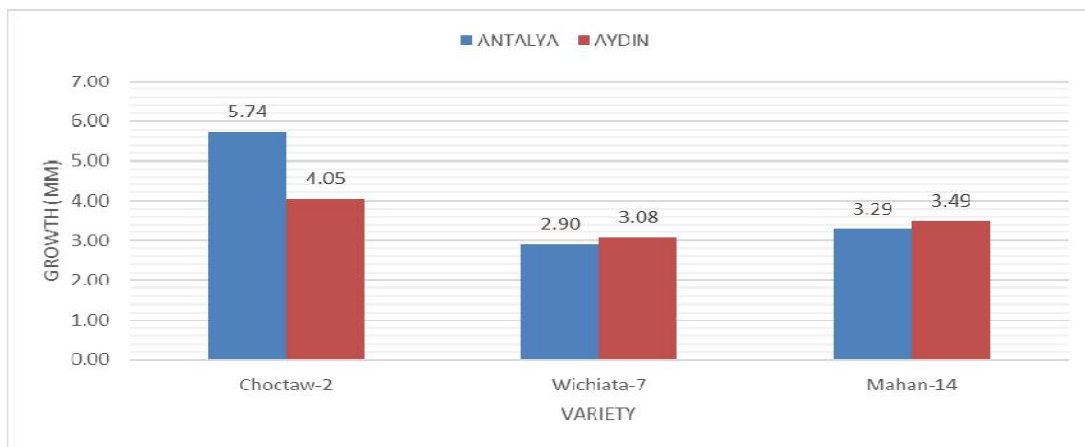


Fig. 5. Development of rootstock diameter at the end of the period according to the beginning of the period (mm)

The difference between repeated measurements is important (F = 15.697, df = 2, P < 0.001)

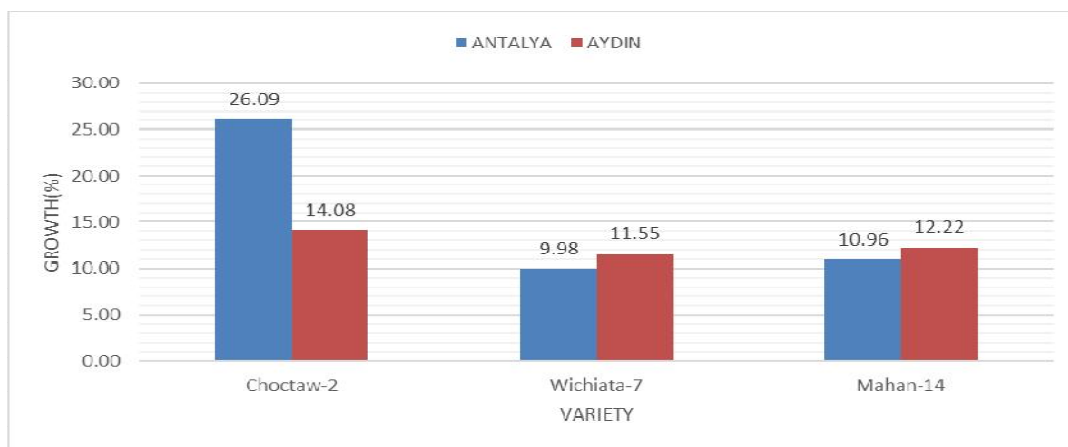


Fig. 6. Diameter development rates of rootstocks at the beginning and end of the period for two years (%)

The difference between repeated measurements is important (F = 15.697, df = 2, P < 0.001)

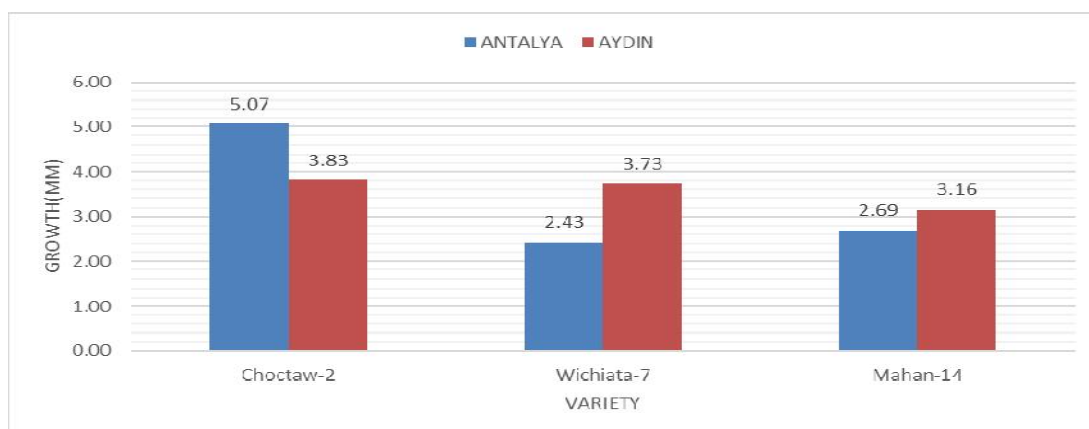


Fig. 7. Two-year average diameter developments of cultivars by regions (mm)
The difference between repeated measurements is important ($F = 18.987$, $df = 2$, $P < 0.001$)

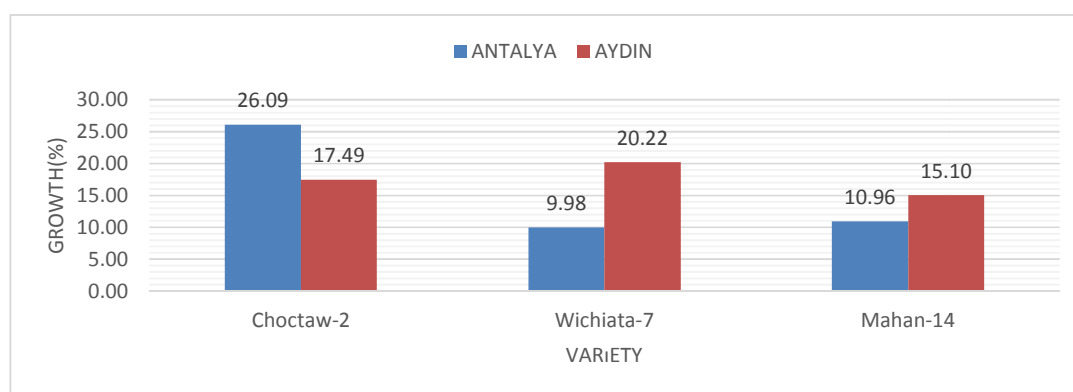


Fig. 8. Diameter development rates of cultivars (%)
The difference between repeated measurements is important ($F = 18.987$, $df = 2$, $P < 0.001$)

their climatic features. In the Antalya region, it is common for the saplings to wake up earlier due to the warming of the weather earlier and the humidity is relatively high.

4. CONCLUSION

In the study, it was observed that pecan did not show a significant difference despite the relatively weak development compared to Antalya province in terms of shoot length development, shoot diameter development, rootstock body diameter development, variety body diameter development. It is seen that Choctaw2 and Wichita7 varieties show better development in Aydin province, but Mahan14 variety is relatively weak, although not important.

The reason for the relatively late awakening of the buds in Aydin is thought to be due to the Aydin region having a relatively cold climate compared to Antalya. Also, the fact that the air

temperatures are high especially in July and August and the relative humidity of the air at the same dates is relatively low compared to the Antalya region can be considered as a reason for the relatively weak development of saplings.

Although, it is generally known as a type of fruit that can grow in subtropic climatic conditions, many researchers working on Pecan cultivation have reported that Pecan can also grow in relatively cold and dry conditions [1,3,5,6,7]. When the data obtained in this study, which is of preliminary nature, is evaluated as a whole, Pecan saplings showed a good development in the ecological conditions of Aydin. These results show that in the province of Aydin, Pecan cultivation can be done except in very cold and very dry places. However, the study should be supported by future fruit productivity studies. The present research findings will be useful for regions with similar climatic conditions.

NOTE

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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