



Comparison of Some Local and Foreign Walnut Cultivars

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Alındığı tarih (Received): 27.03.2018

Kabul tarihi (Accepted): 02.11.2018

Online Baskı tarihi (Printed Online): 08.12.2018

Yazılı baskı tarihi (Printed): 31.12.2018

Abstract: The performance of 12 walnut cultivars ('Şebin', 'Şen1', 'Kaman1', 'Maraş18', 'Maraş12', 'Şen 2', 'Fernette', 'Chandler', 'Howard', 'Midland', 'Fernor', ve 'Pedro') were evaluated under the ecological conditions at Niksar. The research orchard was established planted in 2008 with 7×7 m spacing. Phenological, pomological attributes and yield of cultivars were determined, between 2012 to 2015 years. Leafing of all of Turkish walnut cultivars in this research were found earlier than foreign cultivars. The leafing time of 'Fernor', 'Fernette', and 'Chandler' cv. were the latest among all cultivars. The cultivars with the earliest leaf fall dates were observed as 'Maraş12', 'Maraş18' and Şen2, the latest leaf fall dates were observed as 'Chandler', 'Midland' and 'Pedro'. Nut weight was found between 10.32 g ('Maraş12') - 20.15 g ('Şen 1'), kernel weight 6.17 g ('Maraş12') - 10.69 g ('Şen1'), kernel percentage between 44.92% ('Pedro') - 65.54% ('Şebin'). Shell thickness was noted between 0.85 mm ('Şebin') - 1.97 mm ('Fernor'). The total yield (kg/tree) of cultivars was determined between 2.29 ('Maraş12') and 23.56 ('Pedro'). Later leafing cultivars seem to be more suitable for Niksar ecological region.

Keywords: Walnut, late leafing, yield, pomology, phenology, Niksar

Bazı Yerli ve Yabancı Ceviz Çeşitlerinin Karşılaştırılması

Öz: Bu çalışmada, 2012-2015 yılları arasında, Niksar ekolojik koşullarında, 12 ceviz çeşidinin ('Şebin', 'Şen1', 'Kaman1', 'Maraş18', 'Maraş12', 'Şen2', 'Fernette', 'Chandler', 'Howard', 'Midland' 'Fernor', ve 'Pedro') performansları araştırılmıştır. Araştırma bahçesi, 2008 yılında, 7x7 m dikim sıklığında kurulmuştur. Çeşitlerin morfolojik, pomolojik ve verim değerleri incelenmiştir. İncelenen yerli çeşitlerin tamamı yabancı çeşitlerden daha erken yapraklanmış. En geç yapraklanan çeşitler 'Fernor', 'Fernette' ve 'Chandler', en erken yapraklanan çeşitler ise 'Maraş12', 'Maraş18' ve Şen2 çeşitleri olarak gözlemlenmiştir. En geç yaprak döken çeşitler, 'Chandler', 'Midland' ve 'Pedro' çeşitleri olarak bulunmuştur. İncelenen çeşitlerin ortalama kabuklu meyve ağırlığı 10.32 g (Maraş12) - 20.15 g (Şen1), iç ceviz ağırlığı 6.17 g ('Maraş12') - 10.69 g (Şen1), iç ceviz randımanı 44.92% ('Pedro') - 65.54% ('Şebin'), kabuk kalınlığı 0.85 mm ('Şebin')-1.97 mm ('Fernor') arasında bulunmuştur. Toplam verim değerleri ise (kg/ağaç), 2.29 ('Maraş12') ile 23.56 ('Pedro') arasında tespit edilmiştir. Geç yapraklanan çeşitler Niksar ekolojik koşulları için daha uygun görülmüştür.

Anahtar Kelimeler: Ceviz, geç yapraklanma, verim, pomoloji, fenoloji, Niksar

1. Introduction

Walnut (*Juglans regia* L.), a member of the family *Juglandaceae*, is the most important species among other 18 species. Natural walnut populations grown from seed are usually located within the borders of the rivers or agricultural areas as scattered trees in Turkey. In the past years, the walnut orchards in Turkey were from seedling trees and therefore the nut production was various

and nut quality were differed (Şimsek2010; Gülsoy et al. 2016).

But, the new commercial plantings have been established with standard domestic and foreign walnut varieties on *Juglans regia* L. seedling rootstocks in the major fruit areas.

According to the agricultural statistics, Turkey has derived 210 000 tons of walnut from the total number of 16 661 339 trees in 92 013 ha.

production area, and the average yield is about 24 kg/tree (TSI 2017). Domestic walnut cultivars such as ‘Yalova1’, ‘Şebin’, ‘Yalova2’, ‘Bilecik’, ‘Yalova3’ have long been the important choice of Turkish growers (Şimşek 2015; Akça 2016). These cultivars have not been planted in recent years due to their early leafing habit and these local cultivars are susceptible to pests and diseases especially bacterial blight, and spring frost. The yields of these cultivars are very low when compared to Californian and French cv. (Akça 2016). ‘Chandler’ and ‘Fernor’ cultivars have been used in the establishing of new walnut orchards in Turkey.

The aim of this research is to compare the main agronomic characteristics of Turkish and foreign walnut varieties in Niksar ecological conditions.

2. Material and Method

The research orchard was established in 2008. The trees were planted in 7 x 7 m spacing. In this study, the walnut cultivars ‘Şebin’, ‘Şen1’, ‘Kaman1’, ‘Maraş18’, ‘Maraş12’, ‘Şen2’,

‘Fernette’, ‘Chandler’, ‘Howard’, ‘Midland’, ‘Fernor’, and ‘Pedro’ were evaluated. *Juglans regia* L. seedlings were used as rootstocks in this orchard. The experiment was designed according to completely randomized design (CRD). The observations were made on 12 walnut trees for each cultivar (4 repetitions and 3 plants for each cultivar). The chemical and organic fertilization has been applied annually. 30 kg/ha pure nitrogen, 40 kg/ha net phosphorus and 50 kg/ha potassium fertilization were made in the research orchard in 2013. Also, 10 tons / ha of manure was used annually. The standard pest and diseases management has been applied. The drip irrigation system was used in the orchard.

The research orchard area is characterized by minimum temperature -15.16 °C, maximum temperature of 38.17 °C and average annual rainfall is 405.5 mm. The most important climate restriction for walnut production is early spring frosts in Niksar region. The soil characteristics of orchard soil are given Table 1.

Table 1. Soil characteristics of the research orchard

Çizelge 1. Araştırma bahçesinin toprak özellikleri

Soil Characteristics	Deep of sample soils (cm)	
	0 -30	30 -60
Water holding capacity (%)	50	50
Total Salt (%)	0.021	0.020
pH	7.98	8.02
Lime (%)	5.9	6.3
Phosphor (Available P ₂ O ₅ ,kg/da)	6.95	4.05
Potassium (Available K ₂ O,kg/da)	121	75
Organic matter (%)	1.77	1.49

The phenological, pomological and yield traits that are listed below were investigated according to UPOV between 2012 and 2015 years. The symptoms of walnut blight were also evaluated. Based on the number, size and distribution of lesions on leaves, 0 to 4 severity scale was used according to Özaktan et al (2011).

Phenological characteristics: Leafing date, male and female blooming date, harvest date, date of leaf fall.

Pomological characteristics: Nut dimension, nut weight, kernel weight, kernel percentage, shell thickness, kernel color.

Morphological characteristics: Trunk diameter, growth habit, vigor and density of branches. Tree of trunk diameter was measured at 10 cm above grafting point.

Yield: Average and total yield was determined as kg/tree.

3. Results and Discussion

This study was made to compare main Turkish cultivars with foreign commercial varieties from France and California between 2012 and 2015 years. Leafing dates of cultivars are given in Table 2. Leafing time of walnut cultivars were determined between 24 March ('Maraş12') and 25 April ('Fernor'). The leafing time of Turkish walnut cultivars; 'Şebin', 'Şen1', 'Kaman1', Maraş-18, 'Maraş12' and 'Şen2' are earlier than foreign cultivars 'Fernette', 'Chandler', 'Howard', 'Midland', 'Fernor', and 'Pedro'.

Jupâneşti, Franquette, Lara, 'Fernor' and 'Fernette' are later in bud break (Botu et al. 2007). The leafing time of 'Fernor', 'Fernette', 'Chandler', 'Howard', 'Pedro' and 'Midland' are rather late than 'Şen1', 'Maraş12', 'Şebin', 'Maraş18', 'Şen2' and Bilecik walnut in Bursa ecological conditions (Ertürk et al. 2013).

'Serr' walnut variety leaves 15 days earlier than 'Pedro' cv. in Italy's Piemonte region. The late

leafing cultivars; 'Pedro', 'Hartley', 'Corne', 'Parisienne', 'Marbot', 'Mayette', 'Grandjean' and 'Franquette' were found to be high enough to adapt to ecological conditions than other varieties in Piemonte region of Italy (Radicati et al. 1990).

David (1998) reported that the bud break time of 'Pedro', 'Chandler' and 'Howard' cultivars were 15 to 17 days later than 'Serr' cv. in California ecological conditions. The earliest leafing cultivar was 'Payne' (Hendricks, 1998). The leafing dates of 'Hartley', 'Chandler', 'Howard' and 'Hartley', are later than 'Payne' as 17, 17, 16 and 14 days, respectively. The leafing date of 'Chandler' is 7 days before 'Fernor' in Patagonia region of Argentina (Iannamico et al. 2006). In our study, leafing time of 'Chandler' was observed earlier than 'Fernor' as 9 days. The data obtained in from our study are consistent with the information obtained from the above mentioned sources.

Table 2. Phenological characteristics of Turkish and foreign walnut cultivars in Niksar (2012-2015 years)
Çizelge 2. Türk ve yabancı ceviz çeşitlerinin Niksar ekolojik koşullarında (2012-2015) fenolojik özellikleri

Cultivars	Date of Leafing	Date of Male Blooming	Date of Female Blooming	Harvesting Date	Date of Leaf Fall	Dichogamy Status
'Chandler'	16.04	17.04	30.04	29.10	04.12	Protandrous
'Fernette'	24.04	30.04	07.05	22.10	26.11	Protandrous
'Fernor'	25.04	02.05	08.05	22.10	28.11	Protandrous
'Howard'	10.04	13.04	25.04	28.10	28.11	Protandrous
'Kaman1'	09.04	16.04	23.04	17.10	19.11	Protandrous
'Maraş12'	24.03	06.04	14.04	14.10	17.11	Protandrous
'Maraş18'	26.03	05.04	14.04	14.10	19.11	Protandrous
'Midland'	10.04	15.04	27.04	28.10	27.11	Protandrous
'Pedro'	15.04	16.04	27.04	29.10	02.12	Protandrous
'Şebin'	02.04	12.04	24.04	17.10	27.11	Protandrous
'Şen1'	01.04	12.04	20.04	25.10	23.11	Protandrous
'Şen2'	29.03	13.04	17.04	17.10	21.11	Protandrous

Male blooming time was observed between 5 April ('Maraş18') – 16 April ('Kaman1'), and female blooming time was determined 14 April ('Maraş12' and 'Maraş18') – 24 April ('Şebin') in Turkish cultivars. In foreign cultivars, male blooming time was observed between 13 April

('Howard') – 2 May ('Fernor'), and female blooming time was determined 25 April ('Howard') – 8 May ('Fernor') (Table 2.).

The earliest catkin pollen shed was observed in 'Serr' cultivar as the earliest, and the latest in Franquette cv. (Botu et al. 2007). The cultivars

‘Fernor’ and ‘Fernette’ have the advantage of late female flowering which is similar to our results.

Fruits were harvested from early September to the beginning of October. The earliest harvested varieties were ‘Maraş12’ and ‘Maraş18’, the latest harvest varieties were ‘Chandler’ and ‘Pedro’ (Table 2). Early harvest time and early defoliation time are important for the ecological region with short vegetation period. Also, ‘Kaman1’ walnut cultivars have late leafing and early harvest time and early defoliation according to ‘Şebin’, ‘Şen1’ and ‘Şen2’.

According to Bryner’s study (1998); male flowering time of ‘Franquette’, ‘Mayette’, ‘Meylannaise’, ‘Ronde de Montignac’ and ‘Geisenheim Nr 139’ were determined approximately 9-14 May, 12-20 May, 29 May-3 June, 23-28 May and 9-12 May. In the same study, female flowering time of ‘Franquette’, ‘Mayette’, ‘Meylannaise’, ‘Ronde de Montignac’ and ‘Geisenheim Nr 139’ were determined approximately 28 May-4 June, 29 May-3 June, 1-16 June, 27 May-2 June and 19-24 May.

In our research, all the cultivars were observed protandrous (Table 2). Botu et al. (2007) reported that ‘Pedro’, ‘Vina’, ‘Serr’, ‘Chase D9’, ‘Franquette’, ‘Lara’, ‘Fernor’, ‘Fernette’, ‘VL 54 B’ and ‘VL 102 H’ were protandrous. According to results of Ertürk et al. (2014), Bilecik was protogynous, ‘Şebin’, ‘Kaman1’, ‘Maraş12’, ‘Maraş18’, ‘Chandler’, ‘Fernette’, ‘Fernor’, ‘Midland’, ‘Howard’, and ‘Pedro’ were protandrous and ‘Şen1’ and ‘Şen2’ was homogamous. In our study, the time of leaf fall were observed as 17 November (‘Maraş12’) – 4 December (‘Chandler’). The earliest leaf fall times among Turkish cultivars were observed in ‘Maraş12’, ‘Kaman1’, and ‘Maraş18’; and among foreign cultivars ‘Fernette’ and ‘Midland’ (Table 2). In Bursa ecological conditions, leaf fall dates of ‘Maraş12’ was the earliest and followed by ‘Şen2’, ‘Şebin’, ‘Şen1’ and ‘Maraş18’, ‘Howard’, ‘Chandler’ and ‘Pedro’ were the latest (Ertürk et al. 2014). When the cultivars were evaluated in view of their tree vigor, ‘Midland’, ‘Fernor’, ‘Fernette’, ‘Şen1’, ‘Şen2’, ‘Maraş18’ and ‘Kaman1’ were strong, ‘Maraş12’, ‘Howard’,

‘Şebin’ and ‘Chandler’ were medium, and ‘Pedro’ was weak cultivar. Ertürk et al. (2014) reported that ‘Şen1’ and ‘Bilecik’ were highly vigorous, ‘Chandler’, ‘Maraş12’ and ‘Fernor’ were vigorous, ‘Fernette’, ‘Howard’, ‘Maraş18’, ‘Şebin’ and ‘Serr’ were of average vigor, and ‘Şen2’ was the least vigorous cultivar. Growth habit of trees of ‘Fernette’, ‘Fernor’, ‘Maraş18’, ‘Şen2’, and ‘Midland’ had upright habit; ‘Chandler’, ‘Howard’, ‘Kaman1’, ‘Maraş12’ and ‘Şen1’ were semi-upright, and the cultivar ‘Pedro’ and ‘Şebin’ had a spreading form (Table 3). Ertürk et al. (2014) reported that ‘Maraş18’, ‘Fernette’, ‘Fernor’, and ‘Şen2’ had erect habit, ‘Bilecik’, ‘Chandler’, ‘Howard’, ‘Şebin’, ‘Maraş12’ and ‘Serr’ were semi-erect, and the cultivars ‘Şen1’ and ‘Pedro’ had a spreading form.

The average difference rate of tree trunk diameter (%) was changed 72 (‘Maraş18’) to 82 (‘Fernor’). It was determined the average of nut width, nut length and nut cheek varied between 30.55 mm (‘Maraş12’) and 39.97 mm (‘Şen1’), 32.58 mm (‘Maraş12’) and 42.53 mm (‘Şen1’), 36.58 mm (‘Kaman1’) and 48.21 mm (‘Midland’) respectively. The average of nut weight varied between 10.32 g (‘Maraş12’) to 20.15 g (‘Şen1’), kernel weight changed from 6.17 g (‘Maraş12’) to 10.69 g (‘Şen1’), kernel ratio changed from 44.92 (%) (‘Pedro’) – 65.54 (%) and kernel thickness changed from 0.85 mm (‘Şebin’) to 1.97 (‘Fernor’) (Table 4).

Ertürk et al. (2014) reported that nut weight of cultivars ranged between 9.86 g (‘Maraş12’) and 16.80 g (‘Şen1’), shell thickness varied between 1.62 mm (‘Şen1’) and 2.67 mm (‘Howard’), percent kernel was highest in ‘Şebin’ cultivar. Germain (1988), reported that; nut weight ranged from 8 to 12 g and kernel percentage varied between 35 % and 50 % in French walnut varieties ‘Franquette’, ‘Mayette’, ‘Parisienne’, ‘Corne’, ‘Marbot’ and ‘Grandjean’. The kernel weight of ‘Midland’, ‘Chandler’ and ‘Pedro’ walnut cultivars was determined respectively 6.4 g, 6.5 g and 7.3 g, and kernel ratio as 51 %, 48 % and 51 % in Sen Benito conditions (Tulecke and McGranahan 1994).

Table 3. The morphological characteristics of Turkish and foreign walnut cultivars**Çizelge 3.** Türk ve yabancı ceviz çeşitlerinin morfolojik özellikleri

Cultivars	Tree trunk diameter (mm) (2012)	Tree trunk diameter (mm) (2015)	Difference rate of tree trunk diameter (%) (2012 to 2015)	Vigor of Tree	Growth habit of tree	Density of branches
'Chandler'	115±15,07	150±11,83	77	Medium	Semi-upright	Very dense
'Fernette'	91±14,24	118±14,49	77	Strong	Upright	Sparse
'Fernor'	111±12,94	135±5,83	82	Strong	Upright	Sparse
'Howard'	106±10,33	133±10,02	80	Medium	Semi- Upright	Medium
'Kaman1'	105±16,10	132±17,96	80	Strong	Semi- upright	Medium
'Maraş12'	93±12,26	120±16,07	78	Medium	Semi- upright	Dense
'Maraş18'	97±12,65	135±11,31	72	Strong	Upright	Medium
'Midland'	125±11,63	163±13,31	77	Strong	Upright	Medium
'Pedro'	101±17,23	130±14,33	78	Weak	Spreading	Dense
'Şebin'	106±17,21	138±9,87	77	Medium	Spreading	Very dense
'Şen1'	118±9,44	152±8,29	78	Strong	Semi- Upright	Medium
'Şen2'	113±18,06	149±13,57	76	Strong	Upright	Sparse

The cultivated cultivars in Australia, nut weight of 'Chandler', 'Fernor' and 'Fernette'; was determined as 10.6 g, 11.4 g and 11.0 g, respectively (Vanhanen 2010).

The kernel color of 'Chandler', 'Fernette', 'Fernor', 'Pedro' and 'Howard' were determined extra light, 'Kaman1', 'Midland', 'Şebin' and 'Şen1' were light and 'Maraş12', 'Maraş18' and 'Şen2' were light amber.

Table 4. The pomological characteristics of Turkish and foreign walnut cultivars (Average of four years).**Çizelge 4.** Türk ve yabancı ceviz çeşitlerinin (dört yıl ortalaması) pomolojik özellikleri

Cultivars	Nut width (mm)	Nut length (mm)	Nut cheek (mm)	Nut weight (g)	Kernel weight (g)	Kernel ratio (%)	Shell thickness (mm)
'Chandler'	34,73 ±1,10	38,18±1,32	41,33±1,76	13,68±0,77	6,77±0,41	50,16±1,84	1,41±0,11
'Fernette'	34,73±1,3	37,71±1,37	38,53±1,91	13,90±0,50	6,30±0,28	45,39±0,91	1,72±0,28
'Fernor'	33,44±1,22	37,00±1,63	38,46±0,90	13,69±0,54	6,22±0,39	45,52±2,03	1,97±0,17
'Howard'	33,88±1,85	38,12±1,70	38,37±1,46	14,89±0,44	6,95±0,34	46,44±1,52	1,91±0,13
'Kaman1'	31,85±1,14	37,04±1,34	36,58±1,06	12,95±0,50	7,25±0,38	55,76±0,90	1,19±0,15
'Maraş12'	30,55±0,76	32,58±2,21	37,93±1,62	10,32±1,54	6,17±1,03	59,74±2,93	0,97±0,15
'Maraş18'	32,82±1,41	36,60±1,78	41,65±1,11	12,21±1,09	6,32±0,86	50,72±0,60	1,26±0,10
'Midland'	35,96±0,58	38,13±1,26	48,21±1,46	16,67±0,62	8,59±0,52	51,64±1,90	1,36±0,10
'Pedro'	34,28±1,07	37,70±1,53	43,75±1,19	14,48±1,72	6,52±0,57	44,92±1,11	1,39±0,12
'Şebin'	32,61±1,06	32,72±0,94	38,14±1,14	11,65±0,78	7,66±0,65	65,54±1,96	0,85±0,11
'Şen1'	39,97±1,43	42,53±1,29	47,07±1,75	20,15±0,98	10,69±0,72	53,03±1,74	1,44±0,33
'Şen2'	32,44±0,77	35,76±1,20	42,45±1,24	14,49±0,92	7,16±0,60	49,32±1,90	1,61±0,10

2014 yield values were not determined in the study. Because, the late spring frost (30.03.2014, -3 °C) and hail caused significant damage to trees in 2014. In two years apart from our control, 'Fernor' and 'Fernette' trees are pruned hard. Therefore, the yield values of two varieties are discarded. The total yield values was determined (kg/tree) 2.29 ('Maraş12') and 23.56 kg/tree 'Pedro' (Figure 1). The yield of foreign walnut varieties was higher than that of Turkish walnut varieties. The highest yield was observed in the 'Chandler', 'Pedro' and 'Midland' varieties. The yield of 'Kaman1' cv. was higher than other Turkish varieties. The reason why the yield values of the foreign varieties are higher than the Turkish

varieties can be explained by the rate of lateral bud fruitfulness. The rate of lateral bud fruitfulness of foreign walnut cultivars is higher than Turkish walnut cultivars. Iannamico et al. (2005) reported that 'Tulare', 'Fernor' and 'Chandler' walnut cultivars were most productive.

'Chandler', 'Maraş12', 'Şebin' and 'Şen1' were found to be more susceptible to walnut blight than other cultivars. 'Kaman1' were the most susceptible to anthracnose. 'Şebin' and 'Şen1' were found to be the most susceptible to codling moth (*Cydia pomonella*). Ertürk et al. (2014) reported that same results in Bursa ecological conditions.

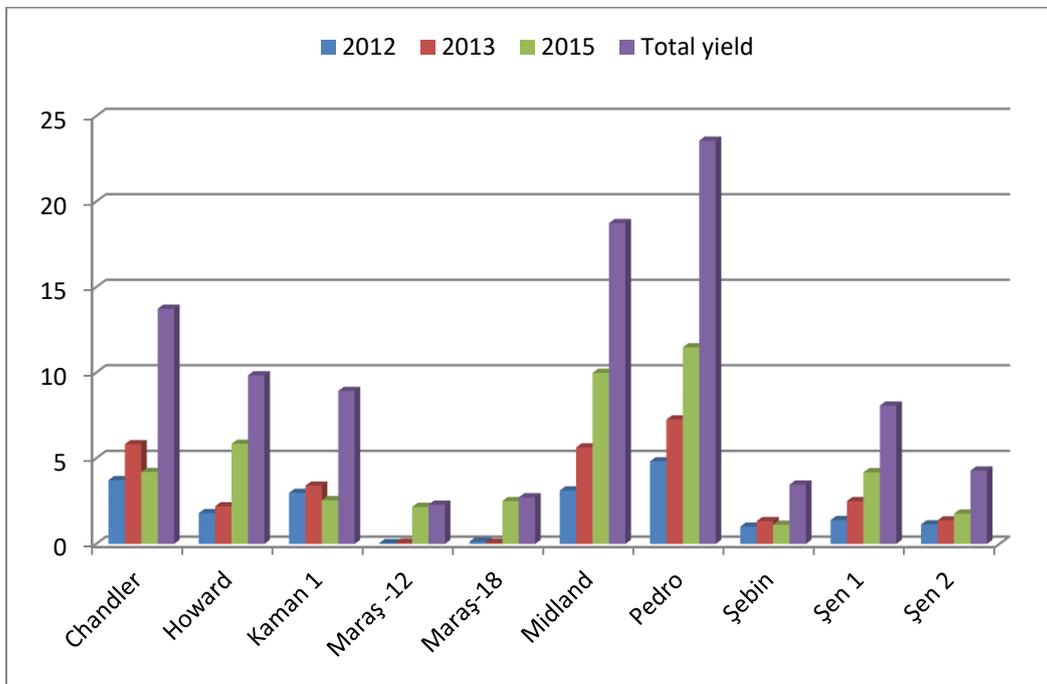


Figure 1. The yield values of Turkish and foreign walnut cultivars cultivars (kg/tree).

Şekil 1. Türk ve yabancı ceviz çeşitlerinin verim (kg/ağaç) değerleri.

Early leafing cultivars are susceptible to spring frosts. Later leafing cultivars seem to be more suitable for Niksar region. 'Pedro', 'Midland', 'Chandler', 'Fernor', 'Fernette', 'Howard',

'Kaman1' were the most promising cultivars at the end of the fourth growing season for Niksar. The research is underway to obtain definite results.

4. Acknowledgement

This study received financial support from the TÜBİTAK for the research project KAMAG 106G152

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