Journal of the American Pomological Society 72(3): 173-180 2018

Walnut Cultivars Through Cross-Breeding: 'DİRİLİŞ' and '15 TEMMUZ'

Mehmet Sütyemez[1*], Akide Özcan[2] and Ş. Burak Bükücü[1]

Additional index words: *Juglans regia* L., cross-breeding, laterally fruitful, fruit set, phenological, pomological

Abstract

This study considered two new walnut cultivars ('Diriliş' and '15 Temmuz') and aimed to evaluate their performance, phenological and pomological traits. The cultivars were obtained through cross-breeding in Turkey. The phenological and pomological traits of mature trees of the cultivars 'Diriliş' and '15 Temmuz' were compared with those of 'Pedro', 'Chandler' and 'Maraş 18' cultivars. Late leafing and a high level of lateral fruitfulness were the most prominent plant traits of the new cultivars 'Diriliş' and '15 Temmuz'. The nut weight, kernel weight and kernel percentage measured 13.70g, 7.23g and 52.83% in the 'Diriliş' cultivar, and measured 14.32g, 7.72g and 53.92% in '15 Temmuz' respectively. Results indicated that these new cultivars have good performance, with phenological and pomological traits that are better or comparable to common walnut cultivars.

Walnut (*Juglans regia* L.) is a commercially important species because of its high quality wood, nutritious nuts and leaves that have significant pharmacological values (Avanzato et al., 2014). Walnut species are found throughout the world including Southern Asia, South Eastern Europe and the Americas (McGranahan and Leslie, 1991; Vahdati et al., 2015). Walnuts are one of several fruit species indigenous to Anatolia, and their long history of fruit cultivation is commonly known (Şen, 1986). The amount of walnuts produced in the world each year is about 2 million tons. Turkey nets an annual production of 200,000 metric tons, and is ranked fourth among the walnut producing countries of the world (FAO, 2016).

Widely used in various fields around the world, walnuts (*Juglans regia* L.) have been studied from many perspectives. Frequently studies have focused on the improvement of productivity and fruit quality, propagation and recently releasing new rootstocks (Dehghan et al., 2009; McGranahan et al., 2009; Vahdati et al. 2004). Meanwhile, spring late frost is one of the most serious problems that cause loss of production in walnuts, and therefore late leafing is a desirable attribute for walnuts grown in regions that are susceptible to spring late frosts (Aslani Aslamarz et al., 2010).

Some genotypes with high variation are important in breeding programs. Walnut breeding programs are characterized by efforts to achieve earlier fruiting, higher yield, lateral fruitfulness, late leafing, good adaptability to different ecological conditions, good fruit quality and tolerance to pests and diseases (Aslantas, 2006; Germain, 1998; Sutyemez, 2016).

Formerly, most walnut cultivars were obtained through selection rather than cross-breeding. Such cultivars include 'Franquette', 'Parisienne', 'Corne', 'Marbot', 'Sorrento', 'Sibisel', 'Payne', 'Maraş 18', 'Sütyemez 1' and 'Kaman 1' (Painter and Rawlings, 1961; Ölez, 1971; Çelebioğlu, 1978; Şen, 1986; Ramos, 1998; Sutyemez, 2016). Nonetheless, walnuts have also been cross-bred over the past two to three decades, and a few cultivars

[1] Department of Horticulture, Faculty of Agriculture, University of Kahramanmaras Sutcu Imam, Kahramanmaras, Turkey
[2] Afsin Vocational School, University of Kahramanmaras Sutcu Imam, Kahramanmaras, Turkey
[*] Corresponding author: e-mail: sutyemezmehmet@gmail.com

with superior traits have been commercialized as a result, e.g. 'Fernor' and 'Fernette' from France (Germain, 1998) and 'Chandler' from USA (Ramos, 1998).

The walnut cultivar improvement program conducted by Forde and Serr at the University of California, Davis from 1948 to 1978 was the first cross-breeding improvement project in the world. This program produced many new cultivars with improved productivity and quality attributes including high lateral bud fruitfulness, large nut size, kernel percentage, light kernel color, easy removal of kernels from the shell and relatively thin shells (Mc Granahan and Forde, 1985). 'Serr', 'Chandler', 'Sundland', 'Chico' and 'Tulare' were produced by this program (Tulecke and McGranahan, 1994). The ongoing demands for walnut production and export have encouraged scientists to breed new walnut cultivars (Germain, 1998; Ramos, 1998; Sütyemez and Kaşka, 2002; Özcan et al., 2017).

Our breeding program was started in 2004, in order to generate promising cultivars characterized by significant production and late leafing, early bearing, higher nut quality and resistance to bacterial blight. The aim of the present study was to evaluate the performance, phenological and pomological traits of two new walnut cultivars produced by the walnut breeding program at the University of Kahramanmaras Sutcu Imam (KSU). The breeding program spanned 13 years, from 2004 to 2016, and the cultivars were registered and patented as 'Diriliş' and '15 Temmuz'. The objective of this study is to evaluate the performance, phenological and pomological traits of 'Diriliş' and '15 Temmuz' in comparison with 'Chandler'.

Materials and Methods

'Diriliş' and '15 Temmuz' were the progeny of 'Pedro' and 'Maraş 18'. The 'Chandler' cultivar was also evaluated and contrasted with the two new cultivars. The study was located in the Nut Application and Research Center (SEKAMER), Kahramanmaras, Turkey. SEKAMER is located at 37° 35' 27" N latitude, 37° 03' 28" E longitute and 930 m above sea level. The region has

Table 1. Descriptors of the phenological traits used to compare five walnut cultivars [z].

Traits	Description
Leafing date	Date when 50% of terminal buds had enlarged and the bud scales had split exposing the green leaves
First male bloom date	When first pollen shedding occurred
Last male bloom date	When last pollen shedding occurred
First female bloom date	Date of initial pistillate flower receptivity
Last female bloom date	Date of last pistillate flower receptivity
Harvest date	When nuts are harvestable
Defoliation date	Date of defoliation
Male flowering times	Catkins receptive duration
Female flowering times	Female flower receptive duration
Female abundance	Female flower abundance: 3 low; 5 intermediate; 7 high
Catkin abundance	Male flower abundance: 3 low; 5 intermediate; 7 high
Lateral bud flowering (lateral fruitfulness)	Percent of lateral buds with female flowers
Dichogamy	Female flowers and catkins receptive duration overlap status: 1 Protandrous; 2 Protogynous; 3 Unknown
Estimated yield	Rate in relation to age and volume of tree: 3 Low; 5 Intermediate; 7 High

[z] Source: IPGRI, 1994

Table 2. Descriptors of the pomological traits used to compare five walnut cultivars [z].

Traits		Description
Shell texture		1: Very smooth; 3: Smooth; 5: Medium; 7: Rough; 9: Very rough
Shell color		1: Very light; 3: Light; 5: Medium; 7: Dark; 9: Very dark
Shell seal		1: Open or very weak; 3: Weak; 5: Intermediate; 7: Strong; 9: Very strong
Shell strength		1: Paper; 3: Weak; 5: Intermediate; 7: Strong
Shell thickness (mm)		Near center of half shell was measured with digital caliper.
Shell integrity		1: Incomplete shell; 2: Intermediate; 3: Complete shell, no holes
Nut weight (g)		Average of total 400 nuts
Kernel weight (g)		Average of total 400 nuts
Nut diameter (mm)		Average of total 400 nuts
Nut height (mm)		Average of total 400 nuts
Kernel percentage (%)		Kernel weight/nut weight × 100
Packing tissue thickness		1: Very thin and sparse; 3: Thin; 5: Medium; 7: Thick; 9: Very thick
Kernel veins (%)		Percent of kernels with conspicuous veins
Kernel fill		3: Poor; 5: Moderate; 7: Good
Kernel plumpness		3: Thin; 5: Moderate; 7: Plump
Ease of removal of kernel halves		1: Very easy; 3: Easy; 5: Moderate; 7: Difficult; 9: Very difficult
Kernel color	Extra light (%)	Percent of kernels in extra light category
	Light (%)	Percent of kernels in light category

[z] Source: IPGRI, 1994

a mild climate - an average between Mediterranean and Continental climates with 727 mm yearly precipitation and 16.9°C average yearly temperature. The soil structure in general is suitable for walnut cultivation, and the plants in this study were irrigated regularly. The trees of each cultivar, were propagated on 'Maraş 18' seedling rootstocks. Ten plants with similar growing qualities were used for each genotype. The research started in 2004, and the phenological and pomological data were collected since 2012, when the plants reached maturity and the orchard became productive. Data collection continued until 2016, and IPGRI procedures and criteria were used (IPGRI, 1994; Anonymous, 1999; Hendricks et al., 1985).

Phenological traits. Phenological traits were assessed according to the walnut descriptor (IPGRI, 1994) (Table 1). Phenological observations were recorded for 10 different trees per cultivar. In this study, 14 phenological traits were evaluated to assess the range of variation among the cultivars, and data pertaining to 2014-2016 are reported.

Pomological traits. Pomological measurements were made on 20 healthy nuts taken from each of 10 trees per cultivar during 2014-2016. Mean values were calculated after measuring several traits with laboratory equipment. Nut and kernel weights were measured using an electronic balance with 0.01 g precision. Nut diameter, length and shell thickness were measured using a digital caliper. Additional traits of the nuts and kernels were determined according to IPGRI, 1994 (Table 2).

Data analysis

In this study, the results were analysed statistically by One Way Analysis of Variance (ANOVA) and means were compared with Tukey's HSD Post Hoc Test using SPSS version 20.0 package program. In the analysis of phenological data, the number of days between 1 Jan. and the date of data collection were considered as the time span for analyses.

Table 3. Five walnut cultivars grown at the Nut Application and Research Center (SEKAMER), Kahramanmaras, Turkey.

Cultivar	Geographic origin	Genetic Origin
Diriliş	University of Kahramanmaras Sutcu Imam, Turkey	Maraş 18 × Pedro
15 Temmuz	University of Kahramanmaras Sutcu Imam, Turkey	Pedro × Maraş 18
Chandler	University of California, USA	Pedro × UC 56-224
Pedro	University of California, USA	Conway-Mayatte × Payne
Maraş 18	University of Kahramanmaras Sutcu Imam, Turkey	Selection from local populations from Kahramanmaras province

Results and Discussion

Phenological traits. The phenological traits of the cultivars were monitored annually throughout the growing season (Table 4). The harvest period of 'Diriliş' was 10-17 Sept. (average, 14 Sept.) and the harvest period of '15 Temmuz' was 21-25 Sept. (average, 23 Sept.). Accordingly, the new cultivar 'Diriliş' was harvested 9 days before 'Chandler', 15 days before 'Pedro' and 1 day before 'Maraş 18'. Meanwhile, '15 Temmuz' was harvested 21 days before 'Chandler', 6 days before 'Pedro' and 8 days after 'Maraş 18'.

Leaves emerged during 28 April - 6 May for 'Diriliş' and during 5-13 May for '15 Temmuz', compared to 25 April - 3 May for 'Chandler', 26 April - 5 May for 'Pedro' and 14-24 April for 'Maraş 18' cultivars. On average, the leafing date between 2014 and 2016 was 2 May for 'Diriliş' and 9 May for '15 Temmuz'. Late leafing is a desirable trait for walnuts grown in regions that experience late spring frosts. This study indicated that the first leafing date of 'Diriliş' and '15 Temmuz' occurred after the leafing for 'Chandler', 'Pedro' and 'Maraş 18' (Table 4; Fig. 1). Defoliation date is another important trait in fruit breeding to avoid early autumn frosts. In this respect, the defoliation dates for 'Diriliş' and '15 Temmuz' were 13 and 17 Nov., respectively (Fig. 1).

Fruit set on lateral branches is a very important trait that influentially defines the productivity of a walnut cultivar and substantially determines the process of selecting a walnut genotype and introducing it as a new cultivar (Ramos, 1998). Furthermore, female flower abundance is also an important indicator of phenological productivity. Today, 'Chandler' is acknowledged as a quite productive walnut cultivar in terms of phenological productivity because its fruit set occurs prominently on the lateral sides of branches (85-90%) (Ramos, 1998). The 'Diriliş' cultivar was found to be similar to 'Chandler' in terms of productivity and the amount of fruit set on lateral sides of branches. However, the '15 Temmuz' cultivar had higher yield compared to 'Diriliş' and 'Chandler' (Table 5).

Table 4. Some important phenological traits of 'Diriliş' and '15 Temmuz' compared to their parents and 'Chandler'.

Cultivars	Leafing date	Leafing date range	Harvest date	Harvest date range	Defoliation date	Defoliation date range
Diriliş	2 May b [z]	28 April-6 May	14 Sept. d	10-17 Sept.	13 Nov. c	8-18 Nov.
15 Temmuz	9 May a	5-13 May	23 Sept. c	21-25 Sept.	17 Nov. c	6-26 Nov.
Chandler	29 April c	25 April-3 May	5 Oct. a	1-10 Oct.	22 Nov. b	16-28 Nov.
Pedro	30 April bc	26 April-5 May	29 Sept. b	26 Sept.-2 Oct.	28 Nov. a	21 Nov.-3 Dec.
Maraş 18	20 April d	14-24 April	15 Sept. d	12-19 Sept	30 Oct. d	21 Oct.-5 Nov.

[z] Values within columns followed by common letters do not differ at the 5% level, by Tukey HSD.

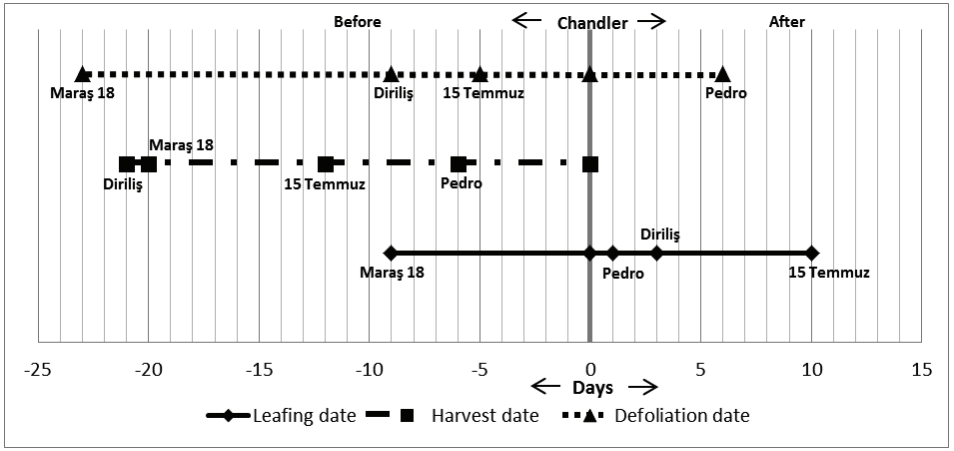

Figure 1. Comparison of some important phenological traits of five walnut cultivars.

Pomological traits. Pomological data were collected during 2014 and 2016, and average values were calculated for each cultivar (Tables 6 and 7). In this study, 'Diriliş' had an average nut weight of 13.70 grams. Its kernel weight measured 7.23 grams and the kernel percentage was 52.83%. On the other hand, '15 Temmuz' had an average nut weight of 14.32 grams, with a kernel weight of 7.72 grams. Its kernel percentage was 53.92%. 'Diriliş' and '15 Temmuz' had heavier nuts and kernels compared to 'Chandler' and 'Pedro'. The kernel percentage was also higher for the two new cultivars, but the values were lower when compared to 'Maraş 18'. Regarding both 'Diriliş' and '15 Temmuz', the

Table 5. Phenological traits of five walnut cultivars grown at the Nut Application and Research Center (SEKAMER), Kahramanmaras, Turkey.

Traits	Diriliş	15 Temmuz	Chandler*	Pedro*	Maraş 18*
Male bloom date range	22 April-2 May	29 April-9 May	18 April-1 May	22 April-1 May	12-19 April
Female bloom date range	3-12 May	8-17 May	29 April-8 May	28 April-8 May	17-28 April
Male flowering times	10	10	13	9	7
Female flowering times	9	9	9	10	11
Catkin abundance	Heavy	Heavy	Heavy	Heavy	Heavy
Female flower abundance	Heavy	Heavy	Heavy	Heavy	Intermediate
Lateral bud flowering range (%)	80-90	85-95	80-90	90-95	50-60
Dichogamy	Protandrous	Protandrous	Protandrous	Protandrous	Protandrous
Estimated yield	High	High	High	High	Intermediate

* Reference Cultivars: Parents ('Pedro' and 'Maraş 18') and 'Chandler'.

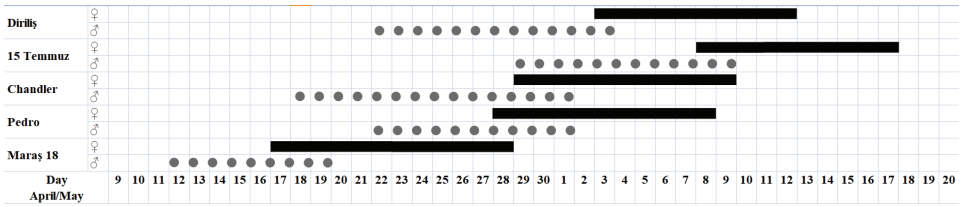

Figure 2. Pollen-shedding period in relation to the time of pistillate blooming of five walnut cultivars.

Figure 3. Fruits of 'Diriliş' and '15 Temmuz' walnut cultivars.

nut shell's texture was 'very smooth' and the shell color was 'very light'. The kernel could be removed easily from the shell, and the color of kernels were 'extra light' or 'light' in both cultivars (Tables 6 and 7).

The nut weights and kernel percentage of some cultivars which are commonly grown in Europe, the US and other regions are as follows, according to existing reports: 'Franquette' (10.75g, 44.50%); 'Mayette' (10.50g, 43.50%); 'Parisianne' (10.75g, 46.50%); 'Corne' (10g, 37.50%); 'Tulare' (13.30g, 53.30%); 'Midland' (12.00g, 44.00%); 'Payne' (11.40g, 50.00%); 'Serr' (13.68g, 57.00%); 'Chandler' (13.26g, 49.00%) and 'Cisco' (12.39g, 46.00%) (Germain, 1988; Glagolev, 1969; Jelenkovic, 1975; Kornienko, 1974; Liu et al., 1991; Ramos, 1998; Schonberg, 1984; Zhadan and Strukov, 1977). By comparing previous reports with data obtained from this study, it is likely that 'Diriliş' and '15 Temmuz' possess higher quality fruit.

This study also reveals that the cross-bred cultivars ('Diriliş' and '15 Temmuz') had favorable values for nut weight and kernel percentage; their qualities are remarkably higher than several domestic and foreign cultivars that are currently planted commercially worldwide. Both new cultivars had high kernel yields and late season leafing dates, i.e. 3-11 days later than the leafing date of 'Chandler'. Both cultivars were harvested earlier than 'Chandler'.

Conclusion

'Diriliş' and '15 Temmuz' walnut cultivars were registered and patented within the framework of walnut breeding studies at the University of Kahramanmaras Sutcu Imam (KSU). Both cultivars possess higher fruit yields, superior fruit quality, later leaf-

ing dates and earlier harvesting periods compared to other commercially grown cultivars in Turkey. In the future, researchers can consider planting these two cultivars in other countries and in different climates to evaluate their adaptability and fruit yields.

Acknowledgements

This walnut cultivar-breeding program was supported by TUBITAK. We would like to thank the institution for their invaluable support. The authors acknowledge Dr. Kourosh Vahdati, Professor of Pomology at University of Tehran for scientific editing of the manuscript.

Literature Cited

Anonymous. 1999. International union for the protection of new varieties of plants. Geneva.

Aslani Aslamarz, A., K. Vahdati, D. Hasani, M. Rahemi and C.A. Leslie. 2010. Supercooling and cold hardiness in the acclimated and deacclimated buds and stems of Persian walnut cultivars and genotypes. HortScience 45 (11): 1-6.

Aslantas, R. 2006. Identification of superior walnut (*Juglans regia* L.) genotypes in Northeastern Anatolia, Turkey. New Zealand J. Crop and Hort. Sci. 34(3): 231-237.

Avanzato, D., G.H. McGranahan, K. Vahdati, M. Botu, L. Iannamico and J. Van Assche. 2014. Following Walnut Footprints (*Juglans regia* L.). Cultivation and Culture, Folklore and History, Traditions and Uses. ISHS. Belgium. pp. 442.

Table 6. Some important nut traits of 'Diriliş' and '15 Temmuz' compared to their parents and 'Chandler'.

Cultivars	Nut weight (g)	Kernel weight (g)	Kernel percentage (%)	Shell thickness (mm)	Nut diameter (mm)	Nut height (mm)
Diriliş	13.70 ± 0.89 c [z]	7.23 ± 0.46 c	52.83 ± 2.10 b	1.43 ± 0.16 b	33.22 ± 1.00 c	42.23 ± 1.66 a
15 Temmuz	14.32 ± 0.93 b	7.72 ± 0.51 b	53.92 ± 1.89 a	1.44 ± 0.15 b	34.60 ± 1.74 b	37.91 ± 2.13 d
Chandler	12.64 ± 1.01 d	6.21 ± 0.56 d	49.14 ± 2.38 c	1.46 ± 0.16 b	34.54 ± 1.53 b	38.90 ± 2.64 c
Pedro	11.41 ± 0.84 e	5.43 ± 0.38 e	47.63 ± 1.99 d	1.44 ± 0.19 b	35.47 ± 1.61 a	39.73 ± 1.85 b
Maraş 18	15.61 ± 0.84 a	8.34 ± 0.63 a	53.44 ± 2.80 ab	1.53 ± 0.14 a	34.66 ± 1.28 b	41.72 ± 1.73 a

[z] Means ± standard deviations within columns followed by common letters do not differ at the 5% level of significance, by Tukey's HSD.

Table 7. Some nut traits of five walnut cultivars.

Traits	Diriliş	15 Temmuz	Chandler*	Pedro*	Maraş 18*
Shell texture	Very smooth	Very smooth	Smooth	Smooth	Very smooth
Shell color	Very light	Very light	Light	Light	Light
Shell strength	Weak	Weak	Weak	Weak	Intermediate
Shell integrity	Complete shell	Complete shell	Complete shell	Complete shell	Complete shell
Packing tissue thickness	Medium	Medium	Medium	Medium	Medium
Kernel veins %	0	0	0	3	4
Kernel fill	Good	Good	Moderate	Moderate	Good
Kernel plumpness	Plump	Plump	Plump	Plump	Plump
Ease of removal of kernel halves	Very easy	Very easy	Very easy	Very easy	Very easy
Extra light % (kernel colour)	49	63	64	52	35
Light % (kernel colour)	51	37	36	48	65

*Reference Cultivars: Parents ('Pedro' and 'Maraş 18') and 'Chandler'.

Çelebioğlu, G. 1978. Ceviz Bahçe Kültürleri Araştırma Eğitim Merkezi, yayın No. 43, 48. Yalova.

Dehghan, B., K. Vahdati, D. Hassani and R. Rezaee. 2009. Bench grafting of Persian walnut as affected by pre- and post-grafting heating and chilling treatments. J. Hort. Sci. and Biotechnol. 85(1): 48-52.

FAO, I. 2016. Food and Agriculture Organization Publications, Rome.

Germain, E. 1988. Main characteristics of the populations and varieties of French walnut (*Juglans regia* L.). Int. Conf. of Walnuts, Atatürk Cent. Hort. Res. Inst. Sept. 19-23. 181.

Germain, E. 1998. Genetic improvement of the Persian walnut (*Juglans regia* L.) production and economics of nut crops course booklets. 18-29 May Adana-Turkey.

Glagolev, V. 1969. An early-flowering walnut, Plant Breed. Abst. Vol. 9 (2) 448 - 3311.

Hendricks, L.C., G.H. McGranahan, D.E. Ramos, B. Iwakiri and H. Forde. 1985. Selection of varieties, p. 46–51. In: D.E. Ramos (ed.). Walnut orchard management. Div. Agr. Natl. Res. Univ. of Calif. Publ. 21410.

IPGRI. 1994. Walnut descriptors for walnut (*Juglans* Spp). International Plant Genetic Resources Institute. IPGRI. Rome, Italy.

Jelenkovic, T. 1975. Some characteristics of selected ecotypes of walnut in the fruit. Plant. Breed. Abst. Vol. 45(5): 313.

Kornienko, N.A. 1974. Types of dichogamy in walnut. Plant Breeding Abst. Vol. 48, No:6 489.

Liu, W.S., S.H. Wang, and Q. Chen. 1991. Breeding report on new walnut selections, Plant Breeding Abst. Vol. 6l (B): 957-7478.

McGranahan, G.H. and C. Leslie. 1991. Walnuts (*Juglans*). Genetic Resources of Temperate Fruit and Nut Crops 290, 907-974.

McGranahan, G.H., C.A. Leslie and T. Gradziel. 2009. Breeding walnuts (*Juglans regia*). Breeding Plantation Tree Crops: Temperate Species. 249-273.

Ölez, H. 1971. Marmara bölgesi cevizlerinin (*Juglans regia* L.) seleksiyon yoluyla ıslahı üzerinde araştırmalar. Bahçe Kültürleri Araştırma ve Eğitim Merkezi Dergisi 4 (1/4):7-21. Yalova.

Özcan, A., Ş.B. Bükücü and M. Sütyemez. 2017. Determination of pollen quality and production in new walnut cultivars. Asian J. Agric. Res. 11 (3): 93-97.

Painter, J.H. and C.O. Rawlings. 1961. Producing walnut in Oregon. Oregon State Univ. Ext. Bull. 795 Corvallis, Oregon, 24, 9. Ramos, D.E. 1998. Walnut production manual. University of Califor. Div. Agric. and Natural Resources Public. 3373. USA.

Schonberg, G. 1984. Results and experience in walnut cultivation. Hort. Abst. Vol. 54(12): 861-895.

Şen, S.M. 1986. Ceviz yetiştiriciliği. Eser Matbaası, Samsun, 229 S.

Sutyemez, M. 2016. New walnut cultivars: Maras 18, Sutyemez 1 and Kaman 1. Hortscience 51(10):1301-1303. 2016. doi: 10.21273/Hortscience-16.

Sütyemez, M. and N. Kaşka. 2002. Bazı yerli ve yabancı ceviz (*Juglans regia* L.) çeşitlerinin Kahramanmaraş ekolojisine adaptasyonu. KSÜ Fen ve Mühendislik Dergisi, 5(1): 148-158.

Tulecke, W. and G.H. McGranahan. 1994. The walnut germplasm collection of the university of California, Davis: Description of The Collection and a History of The Breeding Program of E.F. Serrand H.I. Forde. Rept. Vol. 13. Univ. of. California.

Vahdati, K., C. Leslie, Z. Zamani and G.H. McGranahan. 2004. Rooting and acclimatization of in vitro grown shoots from mature trees of three Persian walnut cultivars. HortScience 39:324-327.

Vahdati, K., S.M. Pourtaklu, R. Karimi, R. Barzehkar, R. Amiri, M. Mozaffari and K. Woeste. 2015. Genetic diversity and gene flow of some Persian walnut populations in southeast of Iran revealed by SSR markers. Plant systematics and evolution, 301(2), 691-699.

Zhadan, V.M. and M.V. Strukov. 1977. Breeding walnut for fruit size. Plant, Breeding Abst. Vol. 47, No: II, 918-10805.