Gaziosmanpaşa Üniversitesi Ziraat Fakültesi Dergisi
Journal of Agricultural Faculty of Gaziosmanpasa University
http://ziraatdergi.gop.edu.tr/

Araştırma Makalesi/*Research Article*

JAFAG
ISSN: 1300-2910
E-ISSN: 2147-8848
(2018) 35 (3), 297-304
doi: **10.13002/jafag4441**

Selection of Superior Walnut Types With Lateral Bud Fruitfulness and High Nut Quality

Osman Çağrı KILIÇOĞLU[1] Yaşar AKÇA[1]*
[1]University of Gaziosmanpaşa, Faculty of Agriculture, Department of Horticulture, Tokat
(orcid.org/0000-0002-0299-4286); (orcid.org/0000-0002-2198-8826)
*e-mail: akca66@gmail.com

Alındığı tarih (Received): 06.03.2018 Kabul tarihi (Accepted): 08.11.2018
Online Baskı tarihi (Printed Online): 08.12.2018 Yazılı baskı tarihi (Printed): 31.12.2018

Abstract: The aim of this research is to protect genetic resources and to select new types of walnuts in Turhal and Zile walnut populations. Turkey is one of the most important producers of walnut in the world. In 2017, Turkey ranked fourth in world production with 190000 t of production. Juglans regia L. is a very important species commercially grown in Turkey. 55 walnut genotypes grown from seeds and having the lateral bud fruitfulness in walnut population were examined in Turhal and Zile regions. As a result of this examination, 21 genotypes were selected Promising walnut genotypes were selected according to by weighted-rankid method. The percentage of lateral bud fruitfulness of selected types is determined between 35 % (60-TR-12) and 85 % (60-ZL-01). The average of nut weight ranged between 8.16 g (60-TR- 16) and 14.71 g (60-TR-03), kernel weight changed between 3.98 g (60-TR-16) and 7.40 g (60-ZL-01), nut length was determined 26.41 mm (60-ZL-06) and 42.50 mm (60-TR- 07), nut suture 22.25 mm (60-ZL-06) - 34.58 mm (60ZL-04), nut cheek 23.77 mm (60- ZL-06) - 35.58 mm (60-ZL-02), shell thickness ranged from 0.36 mm (60-TR- 22) to1.48 mm (60-TR-03).

Keywords: Walnut variety breeding, lateral bud fruitfulness, nut quality

Yan Dallarda Meyve Veren ve Meyve Kalitesi Yüksek Ümitvar Ceviz Genotiplerinin Seleksiyonu

Öz: Bu araştırmanın amacı, Turhal ve Zile ceviz popülasyonları içinde yeni ceviz tiplerini seçmek ve genetik kaynakları korumaktır. Türkiye, dünyada önemli ceviz üreten ülkelerden biridir. 2017 yılı istatistiklerine göre 190.000 ton üretimi ile dünyada 4. sıradadır. Juglans regia, Türkiye'de ekonomik olarak yetiştiriciliği yapılan önemli bir türdür. Türkiye'de, uzun zamandır cevizin tohumla çoğaltılması, geniş genetik kaynaklar sunan çok sayıda ceviz ağacı varlığı oluşturmuştur. Bu araştırmada, Tokat ilinin Turhal ve Zile ilçelerinde tohumdan yetişmiş ceviz popülâsyonu içinde yan dallarda meyve veren 55 ceviz tipi incelenmiştir. Araştırmada 21 genotip seçilmiştir.Araştırmada 21 genotip seçilmiştir. Seçilen tiplerde yan dallarda meyve verme oranı %35 (60-TR-12) ile %85 (60-ZL-01) arasında belirlenmiştir. Ortalama kabuklu meyve ağırlığı 8.16 g (60- TR-16)- 14.71 g (60-TR-03), iç ceviz ağırlığı 3.98 g (60-TR-16) to 7.4 g (60-ZL-01) arasında, meyve boyu 26.41 mm (60-ZL-06) 42.50 mm (60-TR-07) arasında, meyve eni 22.25 mm (60-ZL-06)-34.58 mm (60-ZL-04) arasında, meyve yüksekliği 23.77 mm (60-ZL-06)- 35.58 mm (60-ZL-02) arasında, kabuk kalınlığı 0.36 mm (60-TR-22) -1.48 mm (60- TR-03) arasında bulunmuştur.

Anahtar Kelimeler: Ceviz çeşit ıslahı, yan dallarda meyve verme, meyve kalitesi

1. Introduction

Turkey is one of the most important producers of walnut in the world. In 2017, Turkey ranked fourth in the world with a production of 190.000 t (Anonymous 2016). Juglans regia L. is a very important species commercially grown in Turkey. As the walnuts have propagated from seeds in Turkey for along time, lots of seedlings have a valuable walnut germplasm.

Nut quality, yield, late leafing, lateral bud fruitfulness, tolerance to pests and diseases and

early fruiting are the goals of the important special walnut variety breeding program.

In Turkey the walnut breeding program began in the 1970s and the new types and varieties were found during the selection studies. In the studies carried out after the 1970s in Turkey, primarily nut quality was emphasized (Akça 2005). The common aim of the studies was to find the biggest fruit in Turkish walnut populations. 8 walnut genotypes from the different regions of Turkey were selected and propagated by grafting and the new walnut orchards established by these genotypes. The walnut cultivars are selected from seedling walnut populations in Turkey are susceptible to bacterial blight and late spring frosts

The time of leaf bud burst of domestic walnut varieties are earlier than foreign walnut varieties. Due to late spring frost damage, some fluactions are observed in walnut production in Turkey according to years. In the walnut production, the best way to prevent from the late spring frosts is to use late leafing varieties. Therefore, the next Turkish walnut breeding program, walnut varieties with lateral bud fruitfulness and late-leafing walnut varieties are crossed to produce new varieties that are high yielding and late leafing (Akça et al. 2016).

The aim of this research was to protect genetic resources and to select the new types of walnuts with late leafing, lateral bud fruitfulness and high nut quality in Turhal and Zile walnut populations.

2. Material and Method

The research was carried out in Tokat Province of Turhal and Zile districts. In the study, preference in the selection of promising types in the population was based on the characteristics of late leafing, lateral bud fruitfulness and high nut quality. The survey studies were begun in walnut populations in 2015. Twenty walnut genotypes having late leafing, lateral bud fruitfulness and showing no any symptoms of disease or pest were marked in 2015. Fruit samples were taken from the trees marked in harvest time. The genotypes marked in 2015 were observed again in 2016. In addition, 35 new genotypes were selected in the same method in 2016.

Promising walnut genotypes were selected according to weighted- ranking method. The scores of weighted-ranking method were shown Table 1.

Table 1. The scores of the characteristics and their relative values
Çizelge 1.*Özelliklerin puanları ve oransal değerleri*

Treatments	**Nut weight (g)**		**Nut dimension (mm)**		**Kernel percentage (%)**		**Lateral bud fruitfulness (%)**	
Relative scores/Values	20%	Value	15%	Value	25%	Value	40%	Value
Value Ranges	12- 15	9	38.1 >	9	% 60 >	9	% 70 >	9
	10- 12	7	31,9 to 38,	5	%55- 60	7	% 55- 70	7
	8- 10	5	29,1 to 31,8	5	% 50- 55	5	% 40- 55	5
	6- 8	3	23,9 to 29	3	%45- 50	3	%25- 40	3
	6 <	0	23.9 <	1	% 40- 45	1	% 10- 25	1
					%40<	0		

Phenological properties

The leafing time: The time of leafing in which 75% of leaflets are observed, The female flowering: Time of female flowering when sticky liquid is observed at 75% of the female flowers and at least 45 degrees of lobes are separated.

The male flowering: The male flowering time when 75% of pollen are matures.

The leaf fall: Time of leaf fall in which 75% of leaf are fall.

Dichogamy: In the selected genotypes, dichogamy type was evaluated in three different classes, protandry, homogamy, protogyny.

Morphological characteristics

The tree trunk circumference was measured in selected genotypes, and the tree habitus was evaluated in three groups as upright, semi-upright, spreading.

Nut (pomological) properties

The pomological characteristics of 15 nuts randomly selected from the marked promising genotypes were examined and evaluated according to the UPOV criteria (UPOV, 1988). Nut length, nut suture and nut cheek were defined according to the criteria of UPOV 12 and 19 and the measurements were made with a digital caliper of 0.01 mm. In addition, nut weight and kernel weight were weighed by digital scale (0.01 grams). The ratio of kernel weight to nut weight was calculated as kernel percentage (%). Nut shape characteristics in selected genotypes in the study; are determined according to UPOV 9, UPOV 10, UPOV 11, UPOV 13, UPOV 14, UPOV 15, UPOV 16, UPOV 17 and UPOV 18 criteria. Depth of groove in the shell surface was evaluated in three groups as flat, medium, deep. Based on the "DFA of California" walnut color card, the kernel color is grouped as extra light, light, light amber and dark brown

3. Results and Discussion

The present study was performed with 21 walnut genotypes selected from different parts of Turhal and Zile province in Turkey. The geographical coordinates and altitude corresponding to surveyed area are presented in Table 2.

The most important aims of walnut breeding studies; are to obtain variety having earlier fruiting, higher yield, lateral bud fruitfulness, good adaptability to biotic and abiotic stress, high nut quality and tolerant to pests and diseases (Germain 1988; Germain 1989; Akça et all. 2016).

The lateral bud fruitfulness characteristic is the important factor that determined the potential yield in J. regia L. The lateral bud fruitfulness should be 70 to 80% in new promising types that is late leafing. The rate of lateral bud fruitfulness of Turkish walnut cultivars is very low than Californian and French walnut cultivars.

In the selected genotypes, the rate of lateral bud fruitfulness varied from 35% (60-TR-12) to 85% (60-ZL-01) (Table 2). Akça et al. (2015), reported that the rate of lateral bud fruitfulness of selected types was between 50% and 80% in Kemah region.

Turgut (2014), was found between 28-56% in 9 walnut genotypes selected in Midyat of Mardin province, and Kalan (2011) reported 20-100% in selected types in Bingöl. Yarılgaç et al (2005) determined the rate of lateral bud fruitfulness of selected types in Van walnut population between 40-100%. The rates of lateral bud fruitfulness of selected genotypes in our study were found similar results as other researches.

Late leafing is a valuable characteristic to prevent for bacterial blight and early spring frosts. In addition to that lateral fruitfulness is also associated with precocity. Selection for this character is particularly important in Turkey. Because, natural walnut cultivars produce pistillate flowers on shoot from terminal and sub terminal.

The leafing dates of genotypes selected from the Turhal walnut population were between April 2 (60-TR-08, 60-TR-09, 60-TR-11) 08 April (60-TR-07,60-TR- and 06 April (60-ZL-01, 60-ZL-02, 60-ZL-03, 60-ZL-04) and 11 April (60-ZL-22) in selected types in Zile. In Yağlayan village, which is at 1200 altitude in the town of Turhal, the date of leafing was determined between April 11 and 14 (60-TR-16) (Table 2.).

Temperatures of -2 ° C and -1 ° C on March 29 and 22 April in the province of Turhal and Zile in 2016 caused frost damage on walnut trees. The frost that occurred in these dates enabled the selection of the types that did not suffer from frosts in the population.

The leafing date of selected types from different regions of Turkey vary according to the genetic features and ecological conditions. The leafing date of these types is generally reported in April and rarely in May (Öztürkci 2015; Aslansoy 2012; Kalan 2011; Yılmaz 2007). In our study, the date

of leafing in selected genotypes was determined in April, as other studies.

The date of female blooming is between April 14 (60-TR-08, 60-TR-09) - April 21 (60-TR-06, 60-TR- 07) in Turhal genotypes and between April 21 (60-ZL-02, 60-ZL-03, 60-ZL-04) and April 25 (60-ZL-22) in selected types in Zile. Female flowering in Yağlıalan was determined between April 26 and April28 (60-TR-16). Pollen distribution in male flowers were changed between April 12 (60-TR-22) and April 24 (60-TR-06, 60-TR-07) in Turhal and observed April 16 (60-ZL-03, 60-ZL-06) -April 28 (60-ZL-22) in Zile. Pollen distribution in Yağlayan was determined on 1 May (60-TR-16) (Table 2).

According to our observations, apart from 14 walnut selections were protandrous, 5 selections were protogynous and also 2 genotypes were homogenous flowering behavior (Table 2). Akça and Ozongun (2004) reported that among the selected 17 walnut genotypes, 11 genotypes were protogynous and 6 selections were protandrous Akça et al (2015) determined that observed that 3 out of walnut selections were protandrous, 3 selections were protogynous and also 3 genotypes were homogenous.

In selected walnut types, the fruit length was between 26.41 ± 0.26 mm (60-ZL-06) - 42.50 ± 0.44 mm (60-TR-07), the fruit suture was 22.25 ± 0.29 mm (60ZL06) - 34.58 ± 0 ,26 mm (60-ZL-04) and fruit cheek was 23.77 ± 0.26 mm (60-ZL-06) and 35.58 ± 0.59 mm (60-ZL-02) (Table 3).

İmamoğlu (2015), was determined fruit length, fruit suture and fruit cheek as 38.52 mm, 33.50 mm, 31.88 mm, respectively. Şimşek and Osmanoğlu (2010), found fruit length as 42.02 - 35.64 mm and fruit suture as 34.46 - 29.78 mm. Beyhan (2009), reported fruit length as 33.26 - 44.09 mm, fruit suture as30.87 - 36.56 mm and fruit cheek as 34.80 - 39.31 mm, Yılmaz (2007), was determined fruit cheek as 26-34 mm, fruit suture as 25 - 31 mm, fruit length as 30.61 - 39.75 mm. The nut dimensions of selected genotypes in our study were found similar to other research results.

The ideal nut weight should be 13 and 15 g in the new walnut cultivars. The kernel should be easily removable from the shell, uniformly light colored, and weigh 7–10 g or at least 55 % of kernel percentage. A high kernel percentage is desirable commercially for shipping, high yielding, and processing efficiency.

In our study, nut weight was in the range of 8.16±0.11 g (60-TR-16) – 14.71±0,27 g (60-TR-03), kernel weight varied between 3.98±0.07 g (60-TR-16)- 7.40±0.18 g (60-ZL-01) and kernel percentage ranged from % 35.32±0,77 (60-TR-03) to% 59.42±0,86 (60-TR-22). The shell thickness was found as 0.36±0.02 mm (60-TR-22)-1.48±0.03 mm (60-TR-03) (Table 3).

Öztürkci (2015), reported nut weight (10.51-17.27 g), kernel weight (6.11-9.20 g), kernel ratio (% 50.80-59.60) in walnut selected from Hekimhan. Khadivi-Khub et al (2015), determined nut weight (8.00-23.00 g), kernel weight (4.00-14.00 g), kernel percentage (%40.00-72.22) for walnut selections from İran. Also, Ebrahimi et al. (2015), reported that nut weight (7.70-22.33 g), kernel weight (2.30-8.53 g), kernel percentage (%24.66-62.18) for selected walnut types in İran. Akça et al. (2015), have reported that; nut weight as (11.18 to 15.20 g) and kernel percentage as (47.08% to 58.57%) in 24 walnut genotypes selected from Kemah. Turgut (2014) determined the nut weight (10.12-12.49 g), kernel weight (5.24-6.84 g) and kernel ratio 36.65-66.69 %), for the promising walnut selections in Mardin/Midyat. Asma (2012) reported as the nut weight (12.6–17.5 g), kernel weight (6.9–9.1 g) and kernel ratio (47.3–60.8%), shell thickness (0.95–17.5 mm) for the 16 walnut selections in Anatolia. The average nut weight, kernel weight and kernel ratio of selected types in Trabzon was determined as 10.20-12.40 g; 5.20-6.70 g; and 44.50-63.00% respectively by Kırca et al. (2014). Akça and Şen (2001) reported nut weight (7.49–13.93 g), kernel weight (2.61–5.73), shell thickness (1.32–2.45 mm) and nut diameter (22.30–32.26 mm) in walnut selections from the southeastern parts of Turkey.

Table 2. Leafing and , flowering time and tree characteristics of selected walnut (*Juglans regia*) genotypes
Çizelge 2. *Seçilen genotiplerin, yapraklanma, çiçeklenme zamanı ve ağaç özellikleri*

Genotypes	Altitude (m)	Coordinates	Leafing Time	Receptive period of female bloom	The male flowering date	Dichogamy	Tree trunk diameter (mm)	Growth tree habit	Lateral bud fruitfulness (%)	Total scores of weighted-ranking method
60-TR-01	580	040^0. 21^0. 33 N, 036^0. 07^0. 59 E	3-5 /04	18-20 /04	14-15 /04	Protandry	33	Upright	45	470
60-TR-03	550	040^0. 19^0. 39 N, 036^0. 01^0. 23 E	3-5 /04	18-20 /04	22-23 /04	Protogeny	43	Upright	65	535
60-TR-06	590	040^0. 19^0. 45 N, 036^0. 11^0. 02 E	4-8 /04	19-21 /04	23-24 /04	Protogeny	29	Upright	50	540
60-TR-07	590	0400. 190. 45 N, 0360.110.02 E	4-8 /04	19-21 /04	23-24 /04	Protogeny	25	Spreading	65	740
60-TR-08	540	040^0. 19^0. 31 N, 036^0. 12^0. 16 E	2-4 /04	14-16 /04	18-19 /04	Protogeny	64	Upright	45	500
60-TR-09	580	040^0. 19^0. 37 N, 036^0. 12^0. 16 E	2-4 /04	14-16 /04	18-19 /04	Protogeny	34	Upright	65	500
60-TR-11	555	040^0. 18^0. 59 N, 036^0. 15^0. 36 E	2-6 /04	17-19 /04	21-22 /04	Protogeny	36	Upright	50	520
60-TR-12	535	040^0. 23^0. 17 N, 036^0. 07^0. 22 E	3-7 /04	18-20 /04	22-23 /04	Protogeny	40	Upright	35	410
60-TR-13	550	040^0. 23^0. 11 N, 036^0. 08^0. 31 E	3-7 /04	18-20 /04	22-23 /04	Protogeny	38	Upright	50	440
60-TR-14	550	040^0. 23^0. 32 N, 036^0. 08^0. 49 E	3-7 /04	18-19 /04	18-19 /04	Homogamy	40	Upright	65	620
60-TR-15	560	040^0. 23^0. 44 N, 036^0. 09^0. 33 E	3-7 /04	18-19 /04	22-23 /04	Protogeny	35	Spreading	50	540
60-TR-16	1200	040^0. 27^0. 22 N, 036^0. 11^0. 29 E	11-14 /04	26-28 /04	1-3/05	Protogeny	26	Upright	65	500
60-TR-19	520	040^0. 26^0. 20 N, 036^0. 07^0. 01 E	3-5 /04	18-20 /04	22-23 /04	Protogeny	48	Semi-upright	60	690
60-TR-21	510	040^0. 21^0. 11 N, 036^0. 06^0. 08 E	4-6 /04	18-20 /04	18-20 /04	Homogamy	26	Upright	60	395
60-TR-22	560	040^0. 22^0. 36 N, 036^0. 03^0. 13 E	3-5 /04	16-18 /04	12-13 /04	Protandry	33	Upright	65	395
60-ZL-01	690	040^0. 18^0. 47 N, 036^0. 01^0. 25 E	6-9 /04	21-23 /04	25-26 /04	Protogeny	35	Spreading	85	740
60-ZL-02	680	040^0. 18^0. 49 N, 036^0. 01^0. 23 E	6-9 /04	21-23 /04	25-26 /04	Protogeny	50	Upright	50	610
60-ZL-03	660	040^0. 19^0. 39 N, 036^0. 01^0. 23 E	6-9 /04	21-23 /04	16-17 /04	Protandry	30	Upright	65	690
60-ZL-04	670	040^0. 19^0. 39 N, 035^0. 59^0. 36 E	6-9 /04	21-23 /04	16-17 /04	Protandry	45	Upright	50	610
60-ZL-06	630	040^0. 18^0. 22 N, 035^0. 58^0. 46 E	7-10 /04	20-22 /04	16-17 /04	Protandry	38	Upright	65	395
60-ZL-22	740	040^0. 17^0. 51 N, 035^0. 52^0. 37 E	9-11 /04	23-25 /04	27-28 /04	Protogeny	28	Upright	50	450

Akça (et al. 2015), reported shell thickness between 1.11 and 2.33 mm. Another walnut selection researches were reported the mean shell thickness 1.25 - 1.78 (Turgut 2014), 1.32 - 1,62 mm (Kırca et al. 2014), 0.98 - 1.51 mm (Kalan 2011), 0.85 - 2.00 mm (Çelik et al. 2011), 1.26 - 2.06 mm (Aslansoy, 2012), 0.82 - 1.10 mm (Abdiş 2010), 1.3 - 2.1 mm (Reis 2010), 1.90 - 1.27 mm (Şimşek and Osmanoğlu 2010), 0,82- 1,61 mm (Yılmaz, 2007). The shell thickness of selected walnut types in our study was found to be lower than the selected walnut types in different selection studies.

Table 3. The pomological characteristic of selected types
Çizelge 3. *Seçilen tiplerin pomolojik özellikleri*

Genotypes	Nut weight (g)	Kernel weight (g)	Kernel ratio (%)	Shell thickness (mm)	Nut length (mm)	Nut suture (mm)	Nut cheek (mm)
60-TR-01	9.31±0.13	4.88±0.15	52.30±1.23	0.74±0.03	33.99±0.40	26.69±0.36	27.51±0.36
60-TR-03	14.71±0.28	5.19±0.11	35.32±0.78	1.48±0.04	39.70±0.69	29.29±0.26	30.80±0.73
60-TR-06	11.06±0.26	5.80±0.10	52.42±0.52	0.64±0.03	35.81±0.31	29.21±0.38	30.84±0.33
60-TR-07	13.30±0.28	6.70±0.18	50.30±0.69	0.86±0.02	42.50±0.45	31.06±0.27	31.25±0.30
60-TR-08	9.54±0.26	4.87±0.21	50.93±1.21	0.68±0.03	32.80±0.45	27.07±0.34	30.97±0.66
60-TR-09	8.84±0.13	4.15±0.09	46.93±0.64	0.85±0.03	30.39±0.14	24.77±0.17	27.40±0.25
60-TR-11	8.57±0.21	4.75±0.19	55.17±1.27	0.60±0.03	31.86±0.34	30.34±0.40	28.83±0.21
60-TR-12	10.86±0.16	5.01±0.15	46.04±0.79	0.69±0.02	39.82±0.30	29.64±0.23	30.56±0.21
60-TR-13	10.91±0.25	4.69±0.15	42.98±0.99	0.94±0.04	35.20±0.34	28.24±0.36	30.22±0.30
60-TR-14	10.72±0.22	5.43±0.13	50.71±0.69	0.85±0.03	32.23±0.44	29.37±0.28	31.49±0.27
60-TR-15	11.96±0.18	6.28±0.12	52.46±0.55	0.83±0.02	37.15±0.32	27.90±0.26	31.11±0.21
60-TR-16	8.16±0.12	3.98±0.07	48.78±0.41	0.62±0.02	32.03±0.24	27.99±0.23	26.88±0.18
60-TR-19	14.01±0.48	7.26±0.40	51.35±1.23	1.11±0.04	40.89±0.32	31.25±0.22	34.97±0.35
60-TR-21	13.99±0.33	7.15±0.28	50.90±1.03	0.78±0.03	39.70±0.38	33.19±0.27	34.60±0.28
60-TR-22	8.25±0.10	4.90±0.10	59.42±0.86	0.36±0.03	37.14±0.48	25.03±0.19	24.82±0.13
60-ZL-01	12.74±0.19	7.40±0.18	57.98±0.66	0.66±0.03	39.43±0.33	29.16±0.21	32.23±0.75
60-ZL-02	13.89±0.32	7.12±0.26	51.10±1.05	0.84±0.04	38.18±0.49	32.41±0.35	35.58±0.59
60-ZL-03	12.67±0.38	6.36±0.26	50.00±0.78	1.14±0.04	38.95±0.56	29.61±0.29	32.85±0.33
60-ZL-04	13.35±0.21	7.30±0.17	54.61±0.62	0.68±0.02	37.06±0.18	34.58±0.26	33.15±0.28
60-ZL-06	9.47±0.24	5.08±0.15	36.73±0.51	0.68±0.03	26.41±0.27	22.25±0.29	23.77±0.26
60-ZL-22	9.44±0.27	4.53±0.21	47.66±1.14	0.85±0.03	33.19±0.40	28.62±0.24	30.70±0.30

In our study, the nut weight, kernel weight and kernel percentage were found similar to the genotypes selected in other studies. The fruit weights and nuts values in 60-TR-07, 60-TR-19, 60-ZL-02, 60-ZL04 and 60-ZL-01 genotypes were found higher than Chandler.

In our study, five selected genotypes had extra light, five selected genotypes had light colored kernels, ten selected genotypes had light amber, and only one genotype had dark colored kernels (Tab. 2). The walnut selected genotypes in different regions of Turkey had light colored and light amber (Öztürkci 2015; and Aslansoy 2012).

In our study, the walnut color of the selected types was found to be lighter than the other genotypes.

It is seen in our study that 60-TR-07, 60-TR-19, 60-ZL-02, 60-ZL-04 and 60-ZL-01 with high lateral bud fruitfulness and high nut quality can be use as genetic sources in crossing breeding.

4. Acknowledgement

This study received financial support from the University of Gaziosmanpaşa Scientific Research Projects Commission (Project Number: 2015/04).

Table 4. The nut characteristics of selected superior walnut selections
Çizelge 4. *Ümitvar olarak seçilen tiplerin meyve özellikleri*

Genotypes	Shape in longitudinal section through suture	Shape in longitudinal section perpendicular to suture	Shape in cross section	Shape of base perpendicular to suture	Shape of apex perpendicular to suture	Prominence of apical tip	Position of pad on suture	Prominence of pad on suture	width of pad on sutur
60-TR-01	Elliptic	Elliptic	Elliptic	Cuneate	Pointed	Medium	On upper half of nut	Weak	Narrow
60-TR-03	Elliptic	Ovate	Circular	Rounded	Rounded	Strong	On upper 2/3 of nut	Medium	Broad
60-TR-06	Trapezium	Broad trapezium	Circular	Cuneate	Rounded	Medium	On upper 2/3 of nut	Strong	Broad
60-TR-07	Elliptic	Elliptic	Elliptic	Cuneate	Pointed	Strong	On upper half of nut	Weak	Broad
60-TR-08	Circular	Circular	Oblate	Cuneate	Rounded	Medium	On upper half of nut	Weak	Narrow
60-TR-09	Circular	Circular	Circular	Rounded	Emarginated	Medium	On upper half of nut	Weak	Narrow
60-TR-11	Circular	Circular	Oblate	Rounded	Rounded	Medium	On whole length 3	Strong	Broad
60-TR-12	Elliptic	Elliptic	Elliptic	Cuneate	Pointed	Medium	On upper half of nut	Weak	Narrow
60-TR-13	Ovate	Broad ovate	Circular	Rounded	Rounded	Medium	On upper 2/3 of nut	Medium	Medium
60-TR-14	Trapezium	Ovate	Circular	Cuneate	Pointed	Medium	On upper 2/3 of nut	Medium	Medium
60-TR-15	Elliptic	Elliptic	Elliptic	Cuneate	Pointed	Weak 3	On upper half of nut	Weak	Narrow
60-TR-16	Ovate	Broad elliptic	Elliptic	Cuneate	Pointed	Medium	On upper 2/3 of nut	Medium	Medium
60-TR-19	Broad ovate	Broad ovate	Elliptic	Rounded	Rounded	Strong	On upper 2/3 of nut	Medium	Broad
60-TR-21	Trapezium	Broad trapezium	Circular	Rounded	Rounded	Medium	On upper 2/3 of nut	Medium	Medium
60-TR-22	Elliptic	Elliptic	Elliptic	Cuneate	Pointed	Strong	On upper half of nut	Weak	Medium
60-ZR-01	Elliptic	Broad trapezium	Circular	Rounded	Rounded	Medium	On upper half of nut	Weak	Medium
60-ZR-02	Trapezium	Broad trapezium	Circular	Truncate	Truncate	Medium	On upper half of nut	Medium	Medium
60-ZR-03	Elliptic	Elliptic	Elliptic	Cuneate	Rounded	Medium	On upper half of nut	Weak	Medium
60-ZR-04	Elliptic	Broad trapezium	Circular	Rounded	Rounded	Medium	On upper 2/3 of nut 2	Medium	Broad
60-ZR-06	Broad trapezium	Broad trapezium	Elliptic	Rounded	Emarginated	Weak	On upper half of nut	Weak	Narrow
60-ZR-22	Broad trapezium	Broad trapezium	Oblate	Rounded	Truncate	Medium	On upper half of nut	Weak	Medium

5. References

Abdiş A 2010. Breeding walnuts growing in Taşköprü, Tosya town of Kastamonu Province, Ordu University, Graduate School of Natural and Applied Sciences Graduate Thesis Page: 64

Akça Y, and Özongun S (2004). Selection of late leafing, late flowering, laterally fruitful walnut (*Juglans regia* L.) types in Turkey. New Zealand Journal of Crop and Horticultural Science 32(4), 337-342.

Akça Y (2005). Determination an overview of selection breeding studies carried out in Turkey and definition of characteristics for selection breeding of walnut. Bahçe 34, 29-34.

Akça Y, Bilgen Y, and Ercisli S (2015). Selection of Superior Persian Walnut (*Juglans regia* L.) from Seedling Origin In Turkey, Acta Sci. Pol. Hortorum Cultus, 14(3) 2015, 103-114

Akça Y, Sütyemez M, Yilmaz S, and Karadağ H (2016). The new walnut variety breeding program in Turkey. VII International Scientific Agriculture Symposium Jahorina, pp: 461-466 October, 06-09-2016.

Anonymous (2016). FAO (2016) http://www.fao.org/Statistical Databases. Accessed on 05/03/2017

Aslansoy B (2012). Studies on breeding by selection of walnuts (*Juglans regia* L.) in Sultandağı (Afyon) Location. KonyaSelçuk University, Graduate School of Natural and Applied Sciences graduate thesis Page 147s.

Asma B.M (2012). Pomological and phenological characterization of promising walnut (*Juglans regia* L.) genotypes from Malatya, Turkey, Acta Sci. Pol., Hortorum Cultus. Vol. 11. No 4, pp. 169-178.

Beyhan Ö (2009). Relationships researches on breeding by selection of walnut (*Juglans regia*) forms in Akyazi Province Bahçe 38 (2): 1 – 8.

Ebrahimi A, Khadivi-Khub A, Nosrati Z, and Karimi R (2015). Identification of superior walnut (*Juglans regia*) genotypes with late leafing and high kernel quality in Iran, Scientia Horticulturae Volume 193, 22 September 2015

Germain E (1988). Use of The Late Leafing Characters in a Walnut Variety Breeding Program, Intern. Confer. on Walnuts., p: 95-98, Yalova-Turkey.

Germain E (1989). Inheritance of Late Leafing and Lateral Bud Fruitfulness In Walnut Phenotypic Correlations Among Some Traits Of the Trees. First International Symposium on Walnut Production. Sept. 25- 29 Acta Hort. P:125- 143 Budapest, Hungary.

İmamoğlu A (2015). Walnut (*Juglans regia* L.) selection in Nevşehir province center, Avanos and Ürgüp towns Erciyes University, Graduate School of Natural and Applied Sciences graduate thesis Page: 104.

Kalan C (2011). Selection of walnuts (*Juglans regia* L.) naturally grown in Bingöl Yüzüncü Yıl University, Graduate School of Natural and Applied Sciences graduate thesis Page: 98s.

Khadivi-Khub A, Ebrahimi A, and Mohammadi, A (2015). Characterization and selection of walnut (*Juglans regia* L.) genotypes from seedling origin trees Tree Genetics & Genomes, 11:54.

Kırca S, Yarılgaç T, Kırca L, and Bak T (2014). Study on the selection of walnut (*Juglans regia* L.) in Trabzon, Turkish Journal of Agricultural and Natural Sciences. Special Issue No 1, pp. 835:841.

Öztürkci B (2015). Selection of walnuts (*Juglans regia* L) grown naturally in the district of (Malatya) Hekimhan, Yüzüncü Yıl University, Graduate School of Natural and Applied Sciences graduate thesis Page: 57.

Şimsek M and Osmanoğlu A (2010). Selection Selection of Native Walnuts (*Juglans regia* L.) in Mazıdağı (Mardin) (YYU J AGR SCI) 2010,20(2): 131-137

Turgut Y (2014). Selection of walnuts (*Juglans regia* L) grown naturally in the district of Beyazsu (Midyat-Mardin) Bingöl University, Graduate School of Natural and Applied Sciences graduate thesis Page: 62

UPOV (1988). Walnut/ Noyer/ Walnuss, 88-07-01. International union for the protection of new varieties of plants/TG/125/1 (Prog.). Geneva, Switzerland

Yarılgaç T, Kazankaya A, Balta M.F and Özrenk K 2005. Morphological and pomological characteristics of walnuts (*Juglans regia* L.) Grown in central van province, BAHÇE 34 (1): 101 – 107

Yılmaz S (2007). Selection of late leafing and laterally fruitful walnut types (*J. regia* L.) by selection from native population Gaziosmanpaşa University, Graduate School of Natural and Applied Sciences PhD Page:166.