

PHENOLOGIC OBSERVATIONS ON WALNUT GENOTYPES CEVİZ GENOTİPLERİNDE FENOLOJİK GÖZLEMLER

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ABSTRACT

Variation in the phenology of plants is one of the most sensitive ecological responses to climate change. Changes to species' phenology can have a wide range of impacts on agriculture and forestry. Early bud-break is a limiting factor for commercial walnut growing like other species. Frequent late-spring frosts may damage flowers, buds, or nuts at the beginning of their development. For this reason it is very important to know phenology of cultivars. In this study, we determined phenology of 42 walnut genotypes which are grown under same ecological conditions. Date of terminal bud burst differed between mid march and mid april. The earliest burst of male flowers date was April 5 while the latest date was May 1. First female bloom of walnut genotypes/cultivars changed between April 7 and May 10. We observed that most of genotypes had protandry. In general fruit maturation occurred in the second part of September. Leaf drop started November 9 and finished December 15.

Keywords: Walnut, *Juglans regia* L., phenology, flowering, defoliation

ÖZET

İklim değişikliğine karşı, bitkilerin en önemli ekolojik tepkilerden birisi fenolojilerindeki değişikliklerdir. Bitkilerin fenolojilerinde meydana gelen değişimler, ziraat ve ormancılık alanında çok çeşitli etkilere neden olabilir. Tomurcukların erken uyanması, diğer meyve türlerinde olduğu gibi ticari ceviz yetiştiriciliğini de olumsuz olarak etkiler. İlkbahar geç donları sık sık gelişmelerinin başlangıçlarında tomurcuk, çiçek ve meyvelere zarar verebilir. Bu nedenle çeşitlerin fenolojisini bilmek çok önemlidir. Bu çalışmada, aynı ekolojik koşullar altında yetiştirilen 42 ceviz genotipinin fenolojisi incelenmiştir. Tomurcukların uyanma tarihi Mart ayı ortası ile Nisan ayı arasında gerçekleşmiştir. Erkek çiçeklerin en erken uyanma tarihi 5 Nisan olurken, en geç uyanma 1 Mayıs tarihinde gerçekleşmiştir. İlk dişi çiçeklerinin açılması genotipler / çeşitlere göre 7 Nisan ile 10 Mayıs tarihleri arasında değişmiştir. Genotiplerin çoğunun protandri gösterdiği saptanmıştır. Genel olarak, meyvelerin olgunlaşması eylül ayının ikinci yarısında gerçekleşmiştir. Yaprakların dökülmesi ise, 9 Kasım'da başlayarak 15 Aralık'ta sona ermiştir.

Anahtar Kelimeler: Ceviz, *Juglans regia* L., fenoloji, çiçeklenme, yaprak dökümü

1. Introduction

Walnut is a plant belongs to *Juglandaceae* family. Among 21 species, of the *Juglans* genus, the Persian walnut (*Juglans regia* L.) is recognized as the best species. It is the oldest cultivated fruit in the world and Turkey. All walnut species are native to temperate or subtropical climates and deciduous trees with chambered piths, aromatic compounds leaves, and woody –shelled nut. A valuable edible nut is well appreciated because of the enriched with unsaturated fat like linoleic,

oleic acid (Colarič, et al., 2006). They also contain other beneficial components like plant protein (e.g. arginine, leucine), carbohydrates (e.g. dietary fiber), vitamins (e.g. vitamin A, E), pectic substances, minerals (magnesium, potassium, phosphorus, sulphur, copper, iron), plant sterols, photochemicals (phenolic acids, flavonoids, etc.) (Elaine and Feldman, 2002; Fukuda et al., 2003). Walnut has 50% fruit yield and it is proved that the kernel is inevitable for a healthy because of the nutritional components and high energy level.

Breeding of new walnut varieties through hybridization is both difficult and time consuming. Therefore, over the years, horticulturists have selected a number of walnut genotypes with superior characteristics (Sharma et al., 2014).

Walnut grows spontaneously almost all over Turkey. There are many open pollinated walnut seedlings on their own roots in different regions of Turkey and these trees are very large source of genetic diversity. In Turkey walnut selection researches were started at 1969 by Ölez (Ölez, 1971) and still continuous. Selections have been done based on some characters like climatic adaptations, precocity, and high productivity, good quality of nut and kernel and resistance to major diseases. But each genotype show different characteristics in different ecology. Variation in the phenology of plants is one of the most sensitive ecological responses to climate change.

As a result of selection studies, many genotypes selected as the superior. Then some of them are planted to orchard in Atatürk Central Horticultural Research Institute Yalova.

The present study was conducted to determine the phenological characteristics of 42 promising walnut genotypes which are selected from different locations of Turkey and grown in Yalova province.

2. MATERIAL AND METHODS

The experiment was conducted in orchard of Atatürk Horticultural Central Research Institute in Yalova, during two consecutive years (2015-2016). Yalova is located in the Marmara region of Turkey at a 2 altitude. Walnut trees were planted between 1970 and 1996 years on “Balaban” seedling rootstocks as three replications and trees spacing was 7 x 7 m. Origins of genotypes were given in table 1.

Genotypes were observed from early spring time to defoliation. Date of terminal bud break, male and female flowering time, their coincidence on time (dichogamy), fruit maturity time, and fall of leaf time were determined. All data were recorded for two successive years.

Table 1. Origins of genotypes

| Name of Genotypes | Origin |
|-------------------|--------------------------------------|
| Kurtköy | Adapazarı / Sapanca (Marmara) |
| 74/C154 | Kırklareli / Kofcaz (Marmara) |
| Giresun/7 | Giresun / Şebinkarahisar (Black Sea) |
| Giresun/13 | Giresun / Şebinkarahisar (Black Sea) |
| 87/8 | Tekirdağ (Marmara) |
| 65C/116 | Tekirdağ / Malkara (Marmara) |
| 26C/107 | Tekirdağ / Şarköy (Marmara) |
| 142C/127 | Kırklareli / Vize (Marmara) |
| Kocaeli/2 | Kocaeli / Karamürsel (Marmara) |
| 258/49 | Çanakkale / Yenice (Marmara) |
| 14B/19 | İstanbul / Beykoz (Marmara) |
| 7C/140 | Edirne / Havsa (Marmara) |
| 24/Er/37 | Erzincan (East Anatolia) |
| Mersin/3 | Mersin / Mut (Mediterranean) |
| 103/107 | Bursa / Keles (Marmara) |
| 07/Kor/1 | Antalya / Korkuteli (Mediterranean) |

| | |
|-------------|--------------------------------------|
| 35/İz/1 | İzmir / Tire (Aegean) |
| 49/97 | Bursa / İnegöl (Marmara) |
| Muğla/2 | Muğla / Fethiye (Aegean) |
| 156/C17 | Bilecik / İlyasbeyköyü (Marmara) |
| Bursa/2 | Bursa / Yenişehir (Marmara) |
| 58/Ko/21 | Sivas / Koyulhisar (Middle Anatolia) |
| 28/Al/12 | Giresun / Alucra (Black Sea) |
| İstanbul/2 | Yalova / Soğucak Köyü (Marmara) |
| 44001 | Malatya (East Anatolia) |
| Amasya/ 4 | Amasya / Merzifon (Black Sea) |
| Salto/6 | Adıyaman (South-East Anatolia) |
| 214/47 | Çanakkale / Yenice (Marmara) |
| Muşabak | Van (East Anatolia) |
| 1974/8 | Kırklareli / Vize (Marmara) |
| İstanbul/1 | İstanbul / Selamiçeşme (Marmara) |
| Gümüşhane/2 | Gümüşhane (Black Sea) |
| 60/To/24 | Tokat (Black Sea) |
| 83/C/150 | Kırklareli / Kofcaz (Marmara) |
| 144/84 | Bursa / Karaslah Köyü (Marmara) |
| Antalya/7 | Antalya / Elmalı (Mediterranean) |
| Yanık | Adapazarı / Sapanca (Marmara) |
| Tokat/8 | Tokat (Black Sea) |
| 12c/35 | Tekirdağ / Çerkezköy (Marmara) |
| 77/C/105 | Tekirdağ / Şarköy (Marmara) |
| 56/54 | Balıkesir / Bigadiç (Aegean) |
| Oğuzlar /77 | Çorum / Oğuzlar (Black Sea) |

3. Results

Genotypes were observed from early spring time to defoliation for two successive years. Results are given in table 2. Bud breaking time of genotypes differed in both years. In the first year, the earliest and the latest date of terminal bud break were 16 March (26 C/107 and 12 C/35 genotypes) and 13 April (7C/140 and 103/107), respectively. There was approximately a month between first leafing genotype and last leafing genotype.

Table 2. Phenology of walnut genotypes

| Genotypes | Bud Breaking Date | | Male Flower Date | | Female Flower Receptive Date | | Defoliation Date | | |
|------------|-------------------|----------|------------------|----------|------------------------------|----------|------------------|----------|----------|
| | Years | 2015 | 2016 | 2015 | 2016 | 2015 | 2016 | 2015 | 2016 |
| Kurtköy | | 27/03/15 | 30/03/16 | 17/04/15 | 20/04/16 | 01/05/15 | 04/05/16 | 09/11/15 | 19/11/16 |
| 74/C154 | | 09/04/15 | 15/04/16 | 27/04/15 | 30/04/16 | 03/05/15 | 05/05/16 | 19/11/15 | 26/11/16 |
| Giresun/7 | | 01/04/15 | 04/04/16 | 24/04/15 | 27/04/16 | 10/05/15 | 12/05/16 | 19/11/15 | 24/11/16 |
| Giresun/13 | | 08/04/15 | 10/04/16 | 01/05/15 | 05/05/16 | 10/05/15 | 12/05/16 | 09/11/15 | 19/11/16 |
| 87/8 | | 10/04/15 | 12/04/16 | 27/04/15 | 30/04/16 | 05/05/15 | 07/05/16 | 15/12/15 | 17/12/16 |
| 65C/116 | | 11/04/15 | 15/04/16 | 23/04/15 | 27/04/16 | 05/05/15 | 07/05/16 | 15/12/15 | 17/12/16 |
| 26C/107 | | 16/03/15 | 19/03/16 | 07/04/15 | 09/04/16 | 17/04/15 | 21/04/16 | 15/11/15 | 25/11/16 |
| 142C/127 | | 27/03/15 | 30/03/16 | 14/04/15 | 20/04/16 | 01/05/15 | 04/05/16 | 09/11/15 | 19/11/16 |
| Kocaeli/2 | | 07/04/15 | 13/04/16 | 27/04/15 | 30/04/16 | 05/05/15 | 07/05/16 | 15/11/15 | 25/11/16 |
| 258/49 | | 01/04/15 | 04/04/16 | 27/04/15 | 29/04/16 | 07/05/15 | 10/05/16 | 15/11/15 | 25/11/16 |
| 14B/19 | | 02/04/15 | 08/04/16 | 24/04/15 | 27/04/16 | 10/05/15 | 12/05/16 | 19/11/15 | 24/11/16 |
| 7C/140 | | 13/04/15 | 16/04/16 | 27/04/15 | 30/04/16 | 05/05/15 | 07/05/16 | 15/11/15 | 25/11/16 |
| 24/Er/37 | | 01/04/15 | 04/04/16 | 27/04/15 | 30/04/16 | 27/04/15 | 30/04/16 | 15/11/15 | 25/11/16 |
| Mersin/3 | | 01/04/15 | 04/04/16 | 20/04/15 | 23/04/16 | 01/05/15 | 04/05/16 | 15/12/15 | 17/12/16 |
| 103/107 | | 13/04/15 | 16/04/16 | 27/04/15 | 30/04/16 | 05/05/15 | 07/05/16 | 15/11/15 | 25/11/16 |
| 07/Kor/1 | | 12/04/15 | 15/04/16 | 27/04/15 | 30/04/16 | 05/05/15 | 07/05/16 | 15/11/15 | 25/11/16 |
| 35/İz/1 | | 01/04/15 | 04/04/16 | 10/04/15 | 12/04/16 | 23/04/15 | 27/04/16 | 15/11/15 | 25/11/16 |
| 49/97 | | 11/04/15 | 15/04/16 | 23/04/15 | 27/04/16 | 05/05/15 | 07/05/16 | 15/11/15 | 25/11/16 |
| Muğla/2 | | 10/04/15 | 12/04/16 | 27/04/15 | 30/04/16 | 05/05/15 | 07/05/16 | 15/11/15 | 25/11/16 |



| | | | | | | | | |
|-------------|----------|----------|----------|----------|----------|----------|----------|----------|
| 156/C17 | 10/04/15 | 13/04/16 | 27/04/15 | 30/04/16 | 05/05/15 | 07/05/16 | 15/11/15 | 25/11/16 |
| Bursa/2 | 10/04/15 | 12/04/16 | 27/04/15 | 30/04/16 | 05/05/15 | 07/05/16 | 15/11/15 | 25/11/16 |
| 58/Ko/21 | 07/04/15 | 10/04/16 | 23/04/15 | 25/04/16 | 01/05/15 | 03/05/16 | 15/11/15 | 25/11/16 |
| 28/Al/12 | 03/04/15 | 05/04/16 | 01/05/15 | 05/05/16 | 24/04/15 | 27/04/16 | 15/11/15 | 25/11/16 |
| İstanbul/2 | 07/04/15 | 11/04/16 | 27/04/15 | 30/04/16 | 05/05/15 | 07/05/16 | 15/11/15 | 25/11/16 |
| 44001 | 27/03/15 | 29/03/16 | 07/04/15 | 09/04/16 | 17/04/15 | 21/04/16 | 15/11/15 | 25/11/16 |
| Amasya/ 4 | 10/04/15 | 12/04/16 | 27/04/15 | 30/04/16 | 05/05/15 | 07/05/16 | 09/11/15 | 25/11/16 |
| Salto/6 | 01/04/15 | 04/04/16 | 20/04/15 | 22/04/16 | 01/05/15 | 05/05/16 | 15/11/15 | 25/11/16 |
| 214/47 | 02/04/15 | 05/04/16 | 24/04/15 | 27/04/16 | 10/05/15 | 12/05/16 | 19/11/15 | 24/11/16 |
| Muşabak | 07/04/15 | 10/04/16 | 23/04/15 | 27/04/16 | 01/05/15 | 05/05/16 | 15/12/15 | 17/12/16 |
| 1974/8 | 27/03/15 | 30/03/16 | 20/04/15 | 23/04/16 | 01/05/15 | 04/05/16 | 19/11/15 | 24/11/16 |
| İstanbul/1 | 10/04/15 | 12/04/16 | 27/04/15 | 30/04/16 | 05/05/15 | 07/05/16 | 19/11/15 | 30/11/16 |
| Gümüşhane/2 | 01/04/15 | 04/04/16 | 20/04/15 | 23/04/16 | 01/05/15 | 05/05/16 | 15/12/15 | 17/12/16 |
| 60/To/24 | 27/03/15 | 30/03/16 | - | - | 07/04/15 | 09/04/16 | 19/11/15 | 30/11/16 |
| 83/C/150 | 03/04/15 | 07/04/16 | 23/04/15 | 27/04/16 | 01/05/15 | 05/05/16 | 19/11/15 | 30/11/16 |
| 144/84 | 27/03/15 | 29/03/16 | 07/04/15 | 09/04/16 | 17/04/15 | 21/04/16 | 19/11/15 | 30/11/16 |
| Oğuzlar /77 | 12/04/15 | 15/04/16 | 28/04/15 | 30/04/16 | 05/05/15 | 30/04/16 | 15/11/15 | 25/11/16 |
| Antalya/7 | 10/04/15 | 12/04/16 | 27/04/15 | 30/04/16 | 10/05/15 | 12/05/16 | 19/11/15 | 30/11/16 |
| Yanık | 06/04/15 | 12/04/16 | 17/04/15 | 19/04/16 | 22/04/15 | 24/04/16 | 09/11/15 | 19/11/16 |
| Tokat/8 | 01/04/15 | 04/04/16 | 20/04/15 | 22/04/16 | 01/05/15 | 05/05/16 | 15/11/15 | 24/11/16 |
| 12C/35 | 16/03/15 | 19/03/16 | 10/04/15 | 13/04/16 | 23/04/15 | 26/04/16 | 15/11/15 | 25/11/16 |
| 77/C/105 | 25/03/15 | 27/03/16 | 05/04/15 | 09/04/16 | 17/04/15 | 21/04/16 | 19/11/15 | 30/11/16 |
| 56/54 | 02/04/15 | 08/04/16 | 23/04/15 | 27/04/16 | 05/05/15 | 07/05/16 | 15/11/15 | 25/11/16 |

The earliest male flowering date was 5 April and the latest date was 1 May. Male flowers of 77/C105 genotype first opened while Giresun 13 and 28/AL/12 genotypes last opened. Female flowering date of genotype 60/To/24 was 7 April and genotypes Giresun 7, Giresun 13, 14B/19, 214/47 and Antalya/7 were 10 May. Male flower did not occur at the genotype 60/To/24. 28/AL/12. Oğuzlar 77 and 24/Er/37 genotypes showed homogamy and others showed protandry.

Generally, fruits of genotypes matured in second week of September. Only fruits of genotype 74/C154 matured in last week of September. Early defoliation occurred in Kurtköy, Giresun/13, 142C/127, Amasya/4 and Yanık genotypes. This date was on 9 November. The latest defoliation occurred at 15 December. Defoliation of 87/8, 65C7116, Mersin 3, Muşabak and Gümüşhane 2 genotypes were on this date.

In the second year, terminal bud break started 3 days later than first year. The earliest bud breaking occurred in the same genotypes as the previous year. The latest bud break occurred on 16 April in the genotypes 7/C/140 and 103/107. First pollen distributions started in 26C/107, 44001, 144/84 and 77/C105 genotypes on 9 April, two days late than first year. Pollen distributions of Giresun 13 and 28/AL/12 genotypes started on 5 May. Female blossom started on 9 April in 60/To/24. Female flowers of Giresun 7, Giresun 13, 14B/19, 214/47 and Antalya/7 genotypes started last. This date was 12 May. The earliest and latest female blooming genotypes were the same as in the previous year. In this year, no male flower was formed in the genotype 60/To/24 as first year. Nut ripening was also similar to the first year. Defoliation started at 19 November, ten days late than first year. The earliest defoliation occurred in the same genotypes in both years. The latest defoliation occurred on 17 December.

4. DISCUSSIONS

Investigated genotypes were come from different ecological regions. They were selected as promising material where grown origin and planted to Yalova conditions. Genotypes showed differences in their bud breaking time. There was approximately a month difference among genotypes at bud breaking time. Leafing time has a high inheritance rate of 0,96% in walnut (Ramos, 1998). According to Germain (1977), the leafing dates of parents have a significant effect on foliation times of its hybrids. Tosun and Akçay (2005) reported that terminal bud breaking time



of nine Turkish genotypes/cultivar and 6 foreign cultivars were found to be March at the Yalova condition. The time of walnut bud breaking did not depend on only the general climatic conditions of the area, but also specific weather conditions in different years. For this reason there are some differences between two years. Leafing of genotypes started at different times since they were grown at lower altitudes than the location where they were selected. Late-leafing is very important character to avoid spring forest.

According to long term temperature values of Yalova province, in March the lowest temperature is around 4,5 °C. In this case, early leafing genotypes do not carry the risk of spring forest in this location. Due to long period of sunshine and high temperature in July month, sunburn occurred in the fruits of Giresun/13, 28/A1//12, Gümüşhane 2 and 60/To/24 genotypes which are of Black Sea region origin.

Early defoliation is important to escape the autumn frost injury; also late-leafing is very important character to avoid spring frost. When the temperature values of Yalova are examined for long years, it is seen that the lowest temperature in December is around 5,2 °C. Generally all genotypes have shed their leaves until middle of the December. Therefore, it can be said that there is no danger of early frost for walnut genotypes.

Walnut is a hetero-dichogamous species demonstrating protandry, protogyny and homogamy in different genotypes (Sharma, 2004). In this research, two genotypes showed protogyny, two genotypes showed homogamie and a genotype has only male flower, others showed protandry. Floral characters such as bearing habit, abundance of male and female flowers coupled with dichogamy are also important traits used in characterization and variation studies in walnut (Sharma, 2004). Most of selected walnut genotypes have protandrous blossom character in Turkey like in the world (Cerović et al., 2010; Orman and Hepaksoy, 2016; Orman and Hepaksoy, 2017; Orman et al., 2018). Dichogamy genotypes need planting of varieties with early, mid and late blooming traits with sufficient overlapping period of blooming for effective pollination.

5. CONCLUSION

Walnut (*Juglans regia* L.) is a valuable crop being the nut very popular and largely consumed. In Turkey, This species is widely spread throughout the country. Each genotype or cultivar shows different characters. In this study we examined 42 genotypes which are comes from different ecology of the country. Phenology was affected by the ecology. Variation in the phenology of plants is one of the most sensitive ecological responses to climate change. Frequent late-spring frosts may damage flowers, buds, or nuts at the beginning of their development and very late-leafing is very important character. Therefore, genotypes must be tested at the different location before recommending them for commercial cultivation in a region.

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