

Preliminary communication  
*Претходно саопштење*  
UDC 634.51-154.11  
DOI: 10.7251/AGREN1802137S

University of Banjaluka, Faculty of Agriculture

*Agro-*  
*knowledge*  
*Journal* **A**

## The Importance and Practice of Selection Breeding in Walnut

Seyit Mehmet Şen<sup>1</sup>, Turan Karadeniz<sup>2</sup>,  
Faik Ekmel Tekintaş<sup>3</sup>, Emrah Güler<sup>2</sup>

<sup>1</sup>*Kastamonu University, Engineering and Architecture Faculty, Kastamonu, Turkey*

<sup>2</sup>*Abant İzzet Baysal University, Natural Sciences Faculty, Bolu, Turkey*

<sup>3</sup>*Adnan Menderes University, Agriculture Faculty, Aydın, Turkey*

### Abstract

In Turkey, the predominant method of walnut breeding is selection breeding which is the selection of elite genotypes as practiced worldwide. Due to this reason, the method of selecting elite genotypes with the desired agronomic characteristics is a short span and easily practicable. In countries, where the population of walnut is at low scale, hybridization practices are not attempted to acquire desired agronomic characteristics. The hybridization practices are time consuming to get the target genotypes. The walnut varieties improvement programs should include the priority issues such as: late leaf foliage, fruiting in lateral branches, shortening of the vegetation period, early maturity and harvesting, good fruit quality, high yield and resistance to diseases.

*Key words:* Walnut, selection, breeding, late foliage, productivity

### Introduction

As is the case in other countries around the world, breeding studies carried out for the selection of walnut varieties in our country are mostly carried out for selection breeding. For this reason, it is a shorter and easier-to-use method of selecting the varieties with desired characteristics.

At the same time, Anatolia is a large walnut garden, with millions of different walnut genotypes and a strong population. In countries with weak walnut genotypes, attempts are made not obtain walnuts with desired characteristics by hybridization studies.

These projects take a lot of time and are well known to reach the desired destination. However, in order to obtain walnut varieties with superior characteristics, especially in the USA and France, the emphasis is on hybrid breeding studies (Germain, 1998).

Late foliage, fruiting in lateral branches, premature sloughing, shortening of the vegetation period, early harvesting, good fruit quality, high yield and resistance to diseases are among the priority topics in walnut breeding programs. The breeding programs have been completed or are continuing in line with similar targets in the special walnut breeding studies carried out in the USA (McGranahan and Forde, 1985), France, Hungary (Szentivanyi, 1990), Italy, Spain; (Anonymous, 2012).

The most commonly used method in walnut breeding in Turkey is selection breeding. In previous studies made for the selection of walnut varieties with high quality in the seed walnut populations of our country, the types were selected based on the fruit weight and the following studies focused on important properties such as late foliage, short vegetation period and fruit yield in lateral branches. In recent years, the hybridization method has begun to be included in breeding studies.

Female flowers that occur on annual shoots are often harmed by late spring frosts. Especially in recent years there has been an increase in the sudden and severe colds occurrence during the late spring with the climate changes. The number of days of frosting in the spring in our country increases by 50-60 days from the coastal regions to the inland regions. In the regions where late spring frosts are widespread, late foliage is an important breeding objective and efforts are continuing to provide late foliage varieties to these regions.

### The importance of breeding in walnut

The walnut belongs to the Juglandaceae genus of the Juglandales family. Due to the highest quality of fruit, the walnut, *Juglans regia* L., is the most important of the 18 characterized species. Wild forms of walnut spread around most parts of America's eastern and southern coast, in the Andes Mountains, the Greater and Lesser Antilles, Japan, China, India and Turkey, also including South Asia and South-Eastern Europe and Poland's Carpathian. In Turkey there is a possibility to spread them across a wide area extending to the mountains (Ölez, 1970; Şen, 1980).

Rich in many fruit species, Turkey is also a homeland of walnut. During the excavations, both pollen and walnut fruit were found in Giresun, Gümüşhane and Ordu provinces and they were determined to be 15 million years old. Therefore, walnut growing in this region started at least 15 million years ago (Kutluk and Aytuğ, 2001).

Walnut is a kind of fruit which has an important place in economic and cultural life of Anatolian people, which benefited from growing walnut: from timber to fruit, from roots to leaves, from shade to green. Having cultivated walnut for a long time and propagate / spread it with seeds, our country is a rich source of genes. Standardization of the product is necessary for the market. To reach this goal in walnut breeding, it is the primary duty of breeders to thoroughly scan / screen the existing walnut source, to select the individuals with the most superior characteristics, to register them as a new variety and to provide the plant / propagated materials of a standard variety.

In terms of usage, the walnut tree is a double-purpose plant. Both timber and fruit are quite valuable. However, it depends on the value of timber. These rich genetic resources, produced from seeds during the period of thousands of years are endangered of being used for timber production. In this respect, fruit breeders have a great responsibility in saving the richness of genotypes and genes in this population.

The facts about our existing walnut populations have been pointed out to a certain extent and the studies carried out by Ölez (1970) in Marmara region; Şen (1980) in Eastern Anatolia and Çelebioğlu and Ağgül in Eastern Blacksea Region today. Western breeders claim to have a 60% internal rate and the availability of walnuts with 10 to 16 g fruits as a major goal (Leslie et al., 2015). However, as a result of the selection studies made in our country, a large number of genotypes that left behind these values based on internal weight and internal rate were found and reached the propagation stage. Şimşek and Osmanoglu (2010) have determined the internal ratio 63.10% as highest.

Walnut breeding and obtaining a new walnut variety classically starts from hybridization and ends with obtaining a new variety. It has also been reported that there may be selection of trees with the desired characteristics among the natural population of the deciduous trees as the result of production from seeds for thousands of years (Şen, 1986). Thus, germination of seeds resulted in great walnut genetic material in our country (Ölez, 1971; Şen, 1988). Therefore, this practice made selection breeding important in relation to walnut growing. In walnut breeding, there is another reason why selection breeding is preferred to hybridization breeding; the selection of a new type with the desired characteristics with the improvement of both short time and being easier to obtain.

In contrast, hybridization is generally used for strength and rootstock breeding. Selection studies have given many varieties of fruit. Indeed, foreign varieties such as Serr (Serr, 1964) and Payne (Tulecke and McGranahan, 1994) are among the world famous walnut varieties; Şen 1, Şen 2, Tokat 1 (Şen, 1980), Gültekin 1 (Çelebioğlu, 1978), Yalova-3 (Ölez, 1971) were obtained by selection studies in Turkey.

### Purpose in selection

In selection of walnut varieties, the points that are emphasized vary according to the purpose of breeding and researchers. However, some of the features such as fruit weight, internal weight, female flower number, tip and side branch yield, fruit attitude, interior ratio, shell color and inner color are the most emphasized issues. On the other hand, features such as early fruit bearing of the tree, high and regular distribution of fruit, number of fruits in the cluster, tolerance to colds, diseases and damages, late foliage are also important features in selection studies (Şen, 1980; Ölez, 1971; Serr, 1962; Revin, 1990; Pieklo and Czynezyk, 1990; Germain, 1997; Karadeniz and Çelik, 2000).

Varieties, such as high bearing in the tip and side branches, higher than 11-12 g internal weight, 60-65% internal ratio, resistance to disease and insect damages are targets of new breeding programs.

### Application of selection plan

The process of selecting new genotypes starts with pre-selection studies in July-August. In pre-selection studies, the regions where walnuts are located densely are highlighted, and remarkable walnut types are marked in almost the entire work area. From the marked walnut trees, during maturation and at harvest time, random fruits are taken and analyzed in the laboratory. All samples with an internal weight greater than 5.00 g and an internal ratio higher than 50.00% are identified as promising genotypes (Beyhan, 2005; Şimşek and Osmanoğlu, 2010)

In the second period in March, phenological observations are made on specimens marked and sampled in the previous year. From the selected trees, fruit samples are randomly taken from each side of each tree, and measurements are made in the laboratory.

The third period assumes repeated phenological observations in the genotypes previously marked in March. The last fruit samples are taken to be examined in the laboratory in August and October of the same year.

As a result of the study, the genotypes selected as promising are vegetatively propagated by grafting in both field and controlled conditions. In the study, the first evaluations are made by taking into account the fruit growth by considering the properties to be emphasized first, the fruit yield ratio in the side branches, the resistance against disease and harmfulness and the damage from cold. During the selection visits, the fruit of the tree is determined according to the fruit size of the green peel when the fruit size is decided.

This is because it has been determined that there is a significant correlation between the size of the green-shelled fruit and the size of the thick-grounded fruit in the previous selection studies (Amiri et al., 2010). Harvesting walnuts begins at the time when practically the fruit's green crust cracks and 80% of the walnuts can be poured out. On the same evening, the fruit samples are taken from the green crust and thoroughly brushed with a wire brush in a bowl of water and then washed for 3-5 minutes under a sprinkler. After taking the juices of the well-cleaned fruits, they are dried in the shade and placed in cloth bags. Moisture determination is done before the necessary examinations are made on the fruit, and the amount of moisture is reduced to 8-9% in shell walnuts and 5-6% in nuts.

### Physical properties of fruits

Physical properties of fruit refer to the following features: fruit shape, size, density, weight, internal ratio, internal color, shell color and roughness, crust breakage, crustal thickness, crust separation from kernel. All measurements and weights are made from 20 randomly selected nuts (IPGRI, 1994).

Shape: Fruit shape in walnuts; round, long and oval in three groups. In this group, the following formula is used; fruit shape index; smaller than 1.10 are round; 1.11 - 1.25 oval and 1.25 'large are considered long. Shape Index =  $\text{Length} / \text{Width} + \text{Height} / 2$ .

Size: The large diameter (width or height) is taken into consideration as a measure of size according to the standards. In the study, both fruit width and fruit height are considered. The fruit height and fruit width are measured in order to determine fruit size. TSE Crusted Walnut Standard and US Walnut Standard are referred to in the classification of fruit by their size.

Standards are prepared based on the largest diameter averages. According to US standards:

- Larger than 38.1 mm ones are very large
- Between 31.9 and 38.1 mm, large
- Between 29.1 and 31.8 mm medium
- Between 23.9 - 29.0 mm are small

According to TSE 1992 / 1275, November 1990:

- Extra (for round): 27 mm or larger
- Extra (for oval): 26 mm or larger
- Class 1 (round and oval): 24 mm or larger
- Class 2 (round and oval): 20 mm or larger

### Tree characteristics

**Development Status of Trees:** Trees with a height of 1 m above the ground and the branch height are measured by the steel meter and also the number of branching is determined. Development status of tree trunks; vertical, broad and upright. Leaf length is measured by leaf length, leaf width, and leaf shape index. The leaf area is determined by the electronic planimeter. As a starting point in vegetation, the length of the shoot is about 3 cm and the leaflet curves are seen.

**Fruit Percentage in Side Branches:** The number of fruit in the side branches and the fruit distribution in the lateral branches of the whole walnut types to be examined in the selection study are examined.

**Flowering Status:** Opening lines are examined in male and female flowers for at least two years on the types to be investigated. Male flowers are defined as protoglyphs, protoglyty, protogeny that opens female flowers first, homogamy as male and female flowers that open at the same time. Female flowers are considered receptive when the flower has an angle of 45 degrees between the two lobes, when the flower has a pinkish color and can be felt comfortably when it is tangled.

In male flowers, when the tufts are often touched, the period when the green color turns gray and the pollen grains are seen by hand are considered mature periods.

**Altitude of Tree:** The altitude of the tree is measured with an altimeter.

**Selection of Walnut Genotypes:** In the first and second years of the study, if they are not very important, the first selection is made in the genotypes within the limits of fruit weight 10 g, internal weight 5 g and yield 50%. As a result of the research, if the types are not very important features, the types with internal weight of 5 g and the yield of 50% lower are eliminated.

In the above-mentioned sieving process, the following weighed grading method has been utilized for the selection of different inner walnut and shelly walnuts (Table 1).

Tab. 1. Weighed grading method used in the selection process

*Метод тежинских коефицијената кориштен у процесу селекције*

<i>For selection of shelly walnut</i>		<i>For selection of inner walnut</i>	
<i>Weighted Grading</i>		<i>Weighted Grading</i>	
Character	Importance level	Character	Importance level
Weight	22	Weight	25
Yield (%)	20	Yield	25
Size	15	Light color ratio	20
Roughness	9	Separation from the shell	15
Shell color	9	Complete seed	5
Shell thickness	8	Full filled fruit ratio	5
Shell conglutination	5	No. of non-shrunked seed	5
Full filled fruit number	7	-	-
No. of healty complete seeds	5	-	-

The most widely used method in walnut breeding is selection breeding. In selection studies carried out to select walnut varieties with high quality in seed-grown walnut populations, fruit selection, fruit ripening, late foliage, short vegetation period, yield rate in end and side branches, overall yield, internal color, smoothness of shell, tolerance to disease and damage are considered as important parameters in selection studies.

## References

- Amiri, R., Vahdati, K., Mohsenipoor, S., Mozaffari, M. R. and Leslie, C. (2010). Correlations between Some Horticultural Traits in Walnut. *HortScience*, 45(11), 1690-1694.
- Anonymous. (1980). Franquette, L'orbiculture Fruit Varieties
- Beyhan, Ö. (2005). Darende Cevizlerinin (*Juglans regia* L.) Seleksiyon Yoluyla Islahı Üzerinde Araştırmalar. SAÜ Fen Bilimleri Enstitüsü Dergisi 9. Cilt, 1.Sayı.
- Çelebioğlu, G. (1978). Ceviz. Atatürk Bahçe Kültürleri Araştırma Eğitim Merkezi, No: 4348, Yalova.
- Forde, H. I. (1979). Walnuts Advances in Fruit Breeding. West Lafayette: Purdue Research Foundation.
- Germain, E. (1997). Genetic Improvement of The Persian Walnut (*Juglans regia* L.). *Acta Hort.*, Şen. 14(2), 199-205.
- Gumenyuk, Y.V. and Komanich, I. G. (1985). Breeding value of early walnut varieties. *Plant Breed Abst.*, 55(11), 985: 8993.

- IPGRI. (1994). Description for walnut (*Juglans spp.*). Rome, Italy: International Plant Genertic Resources Institute.
- Karadeniz, T. and Çelik, Z.S. (2000). Ercişve Muradiye’de (Van) Yetiştirilen Cevizlerin Seleksiyon Yoluyla Islahı Üzerinde Araştırmalar. OMÜ. *Zir.Fak.Dergisi*, 15(3),7-15.
- Karadeniz, T. and Şahinbaş, T. (1996). Çatakta Yetiştirilen Cevizlerin (*Juglans regia* L.) Meyve Özellikleri ve Ümitvar Tiplerin Seçimi. Fındık ve Diğer Sert Kabuklu Meyveler Sempozyumu. Ondokuzmayıs Üniv. Zir. Fak. (pp. 317-323).
- Kornienko, N.A. (1974). Types of dichogamy in walnut. *Plant Breed. Abst.* 48(6), 489.
- Kutluk, H. and Aytuğ, B. (2001). Davis, Flora of Turkey in Proceedings of the 2 nd Balkan Botanical Congress, Plants of the Balkan Qeninsula: into the next Millenium, Vol. I, Turkey: İstanbul, p 28 -294. S 21-32.
- Leslie, C., McGranahan, G., Hackett, W., Martinez-Garcia, P.J., Wang, G, Ramasamy, R., Chen, L., Walawage, L., Grant, J., Caprile, J., Coates, B., Buchner, R., Hasey, J., Doll, D., Fichtner, E., Pope, K., Dandekar, A., Aradhya, M., Sudarshana, S., Neal, D. and Dvorak, J. (2015). *Walnut Improvement Program 2015*. California Walnut Board, USA.
- McGranahan, G.H. and Forde, H.I. (1985). Relationship between clone age and selection trait expression in mature walnuts. *J. Amer. Soc. Hort. Sci.* 110, 692-696.
- Ölez, H., (1970). *Marmara Bölgesi Cevizlerinin Seleksiyon Yoluyla Islahı Üzerinde Araştırmalar* (Doktora Tezi). Basılmamış, Yalova.
- Ölez, H., (1971). Marmara Bölgesi Cevizlerinin (*Juglans regia* L.) Seleksiyon Yoluyla Islahı Üzerine Araştırmalar. *Yalova Bahçe Kültürleri Araştırmave Eğitim Merkezi Dergisi*, 4(1-4), 7-21.
- Paunovic, S. A. (1990). The Walnut Cultuvars Selected From İndigenous Population of *J. regia* L. In: Sr. Serbia Sfr. Yugoslavia. Frist int. Sym. on Walnut Prod. Acta Hort. 284. Hungary.
- Serr, E. F. (1962). *Selecting Suitable Walnuts Varieties* (p. 144). Davis (California): California Agricultural Experiment Station.
- Serr, E.F. (1964). *The nut crops of Turkey*. Proceedings of the Nut Growers Society Oregon. Washington 50, 11–22.
- Szyentvanyi, P. (1990). *Breeding early fruititng high producing walnut cultivars leafing after late spring frosts*. Paper presented at the First International Symp.of walnut prod. Acta. Hort 284, Sept. 25-29, Budapest, Hungary.
- Şen, S. M. and Tekintaş. E. F. A. (1990). *Study on Selection of Adilcevaz Walnut. XIII. İnternational Horticultural Congress Abstracts of Contributed Papers. I. Oral, Frienze, August 27. September 1, 1121.*



- Şen, S. M. (1988). *Anatolia As A Walnut Garden*. Paper presented at the International Conference On Walnut, Atatürk Central Horticultural Research Institute, Yalova- Türkiye. September (19-24), 21.
- Şen, S. M. (1980). Kuzey Doğu Anadolu ve Doğu Karadeniz Bölgesi Cevizlerinin Seleksiyon Yoluyla Islahı Üzerine Araştırmalar, Doçentlik Tezi, Basılmamış, Erzurum.
- Şen, S. M. (1986). CevizYetiştiriciliği, Eser Matbaası, Samsun.
- Şimşek, M. and Osmanoğlu, A. (2010). Mazıdağı (Mardin) Yöresindeki Doğal Cevizlerin (*Juglans regia* L.) Seleksiyonu.
- Tulecke, W. and McGranahan, G. (1994). *The Walnut Germplasm Collection of the University of California, Davis*. Genetic Resources Conservation Program Division of Agriculture and Natural Resources University of California.
- Zeaches, S. (1969). Pomological Analysis of Selected Types of Walnut. *Hort. Abs.*, 46(10), 789.

## Селекционо оплемењивање ораха: значај и искуства из праксе

Сејит Мехмет Шен<sup>1</sup>, Туран Карадениз<sup>2</sup>,  
Фаик Ехмел Текинташ<sup>3</sup>, Емрах Гулер<sup>2</sup>

<sup>1</sup>Универзитет Кастамону, Факултет инжењерства и архитектуре, Кастамону Турска

<sup>2</sup>Универзитет Abant İzzet Baysal, Факултет природних наука, Болу, Турска

<sup>3</sup>Универзитет Adnan Menderes, Пољопривредни факултет, Ајдин, Турска

### Сажетак

У Турској, најчешћи начин оплемењивања ораха је селекционо оплемењивање, које представља селекцију елитних генотипова, што је најчешћа пракса у оплемењивању широм свијета. Стога, селекција елитних генотипова са пожељним агрономским својствима је релативно краткотрајна и лако изводљива. У државама у којима орах нема значајнију популацију, процеси хибридизације у циљу добијања повољних агрономских особина се ријетко спроводе. Стога, хибридизација у циљу добијања циљаног генотипа је обично дуготрајан процес. Програми оплемењивања различитих сорти ораха требају укључити приоритетне ставке као што су: касно листање, плодоношење у бочним гранама, скраћење вегетационог периода, рана зрелост и берба, квалитет плода, високи приноси и отпорност на болести.

*Кључне ријечи:* орах, селекција, оплемењивање, касно листање, продуктивност

Turan Karadeniz  
E-mail: [turankaradeniz@hotmail.com](mailto:turankaradeniz@hotmail.com)

Received: February 26, 2018  
Accepted: May 17, 2018