The Determination of Promising Genotypes in Native Walnut (Juglans regia L.) Populations of Hani (Diyarbakır) District

Mustafa ÇİÇEK¹, Ersin GÜLSOY¹*, Rafet ASLANTAŞ²

¹Igdir University, Faculty of Agriculture, Department of Horticulture, Igdir, Turkey
²Osmangazi University, Faculty of Agriculture, Department of Horticulture, Eskişehir, Turkey

*Corresponding author: ersin.gulsoy@igdir.edu.tr

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Abstract
This study was carried out to determine the promising walnut genotypes, to two years (2017-2018) in the Hani district of Diyarbakır province. In this study, 19 genotypes were selected as promising from about 4000 seeds origin walnut trees. In these selected genotypes, the fruit weights were between 10.03-15.46 g, kernel weights were between 5.00-6.77 g, kernel rates from 41.18% to 53.65%, shell thicknesses were between 1.47-2.03 mm. In selected genotypes shell color as 'light' for 13 genotypes, as 'dark' for 6 genotypes; inner shell color as 'light' for 6 genotypes, as 'yellow' for 9 genotypes and as 'dark' for 4 genotypes. Blooming habits of promising genotypes were protandrous in 14 genotypes, protogynous in 1 genotype and homogamy in 1 genotype. The lateral fruitfulness ratio was found to be between 0.00% to -100.00 %.

Keywords: Walnut, genotype, selection, Diyarbakır.

Diyarbakır’ın Hani İlçesi Doğal Ceviz Popülasyonu İşlerisinde Ümitvar Ceviz (Juglans regia L.) Genotiplerinin Belirlenmesi

ÖZET
Diyarbakır’ın Hani ilçesinde 2 yıl (2017-2018) süreyle yürütülen bu çalışmada üstün özellik gösteren ceviz genotiplerinin belirlenmesi amaçlanmıştır. Çalışmada yaklaşık 4000 adet tohumdan yetiştirilmiş ceviz genotipi içerisinde 19 genotip ümitvar olarak seçilmişdir. Seçilen genotiplerde, kabuklu meyve ağırlığı 10.03-15.46 g, iç ağırlığı 5.00-6.77 g, iç oranı 41.18%-53.65 ve kabuk kalınlığının ise 1.47-2.03 mm arasında olduğu belirlenmiştir. Seçilen genotiplerin, kabuk rengi 13’ünde ‘açık’, 6’sında ‘esmer’, iç rengi ise 6’sında ‘açık’, 9’unda ‘sarı’ ve 4’ünde ‘esmer’ olarak değerlendirilmiştir. Ümitvar genotiplerin 14’unun protandry, 1’inin protogeny ve 4’unun homogamy çiçeklenme karakteri gösterdiği tespit edilmiştir. Yan dallarda meyve tutma oranının %0.00 ile %100 arasında olduğu görülmüştür.

Anahtar kelimeler: Ceviz, genotip, seleksiyon , Diyarbakır, Hani.

Introduction
Although there are 18 different walnut species in the world, it is Juglans regia L. which is widely cultivated economically. Turkey is one of the world’s oldest country which walnut cultivation (Şen, 1986; Akça, 2001).

Turkey produces annually 210,000 tons walnut and ranking 4th place after China (1,925,403 tons), USA (571,526 tons) and Iran (349,192 tons) (FAO, 2019). Turkey has 11,250,526 bearing walnut trees which a large part has grown from seed (TÜİK, 2019). Our country is in a very rich state in terms of walnut gene resources. Even though our country has very rich walnut gene resources, it is not among the leading countries in the word walnut production. This is due to the fact that still obtained from seed-origin trees the majority of walnut produced in our country. Nowadays, although shows a rapid increase in the number of orchards established with standard cultivars, it is not enough and there are productivity problems. Selection of genotypes showing superior characteristics in terms of yield and quality with selection studies in different regions, receiving of cultivar certificate of
these genotypes, and increasing the number of orchards established with standard cultivars will make significant contributions to walnut production and export (Yıldırım et al., 2005, Demir et al., 2019).

In this study, which is a follow-up of the selection studies conducted in our country was carried out to the aim of selection of the promising walnut genotypes in Hani district of Diyarbakir and their villages, to prevent them from disappearing and to detect their pomological properties.

**Materials and Methods**

**Material**

This study was carried out to determine promising walnut genotypes in the center and villages Hani district of Diyarbakir during the years 2017-2018 in Turkey. Fruit samples were picked from 120 genotypes determined by pre-selection from approximately 4000 walnut populations and examined in terms of fruit characteristics according to walnut selection criteria. In 120 walnut genotypes in 2017, 44 genotypes which had more than 10.00 g of the fruit weight, more than 5.00 g of the kernel weight were selected for second years.

**Method**

For pomological properties such as the fruit weight (g), kernel weight (g), fruit width (mm), fruit length (mm), fruit height (mm), kernel ratio (%), shell thickness (mm), shell color, shell roughness, cracking status, kernel fullness, kernel color, fruit shape, and fruit size were investigated 20 fruit from each genotype. As the phenological observation, first leaf initiation date, flowering/blooming conditions or habit (homogamous, protandrous, protogynous), fruit yield in lateral branches and harvested time were observed.

It was used a weighted-ranked method for comparison of the selected walnut genotypes and evaluation, used by Şen, 1980 and Yarılgaç, 1997 (Table 1). 19 genotypes which had high scores according to the weighted-ranked method were selected as promising.

**Results and Discussion**

The fruit weight, kernel weight, kernel ratio, shell thickness, kernel shrinkage, kernel /rate, shell roughness, shelled and kernel fruit color are among the most important walnut breeding criteria’s in walnut selection studies (Ölez, 1971; Şen, 1980; Paunovic, 1990; Yarılgaç, 1997; Akça, 2009; Sutyemez, 2016).

| Table 1. Criteria’s based on weighted ranking method, relative scores and value scores of these criteria |
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| **Criteria** | **Relative score (%)** | **Value scores** |
| Shelled fruit weight 25 | Very heavy :10 |  |
| | Heavy :8 |  |
| | Medium :6 |  |
| | Light :4 |  |
| | Very light :2 |  |
| Kernel Ratio 20 | Very High :10 |  |
| | High :8 |  |
| | Medium :6 |  |
| | Low :4 |  |
| | Very low :2 |  |
| Shell Color 15 | Light :10 |  |
| | Medium :6 |  |
| | Dark :2 |  |
| Fruit Size 10 | Very big :10 |  |
| | Large :8 |  |
| | Medium :6 |  |
| | Small :4 |  |
| | Very small :2 |  |
| Full Kernel Ratio | %100 | 10 |
| | 80-90 | 6 |
| | ≥70 | 2 |
| Strong Kernel Ratio | %100 | 10 |
| | 80-90 | 6 |
| | ≥70 | 2 |
| Shell Roughness 5 | Straight | 10 |
| | Medium | 6 |
| | Rough | 2 |
| Shell Thickness 5 | Very thin | 10 |
| | Thin | 8 |
| | Medium Thick | 6 |
| | Thick | 4 |
| | Very Thick | 2 |
| Shell Cracking Status 5 | Easy | 10 |
| | Medium | 6 |
| | Hard | 2 |
| Kernel Fullness 5 | Good | 10 |
| | Medium | 6 |
| | Bad | 2 |
| TOTAL | 100 |  |

In this study, according to the results of the weighted-ranked method, 19 walnut genotypes (Hani 4, Hani 7, Hani 14, Hani 19, Hani 20, Hani 32, Hani 43, Hani 58, Hani 59, Hani 64, Hani 68, Hani 70, Hani 84, Hani 85, Hani 87, Hani 89, Hani 95, Hani 105, Hani 119) were selected as promising. Fruit characteristics of 19 genotypes selected as promising are given in Table 2 and Table 3.
According to 2-year averages, shelled fruit width was found to be lowest at 27.38 mm (Hani 14) and highest at 43.03 mm (Hani 116). Shelled fruit length was found to be lowest at 31.20 mm (Hani 20) and highest at 50.12 mm. Shelled fruit height was found to be lowest at 29.15 mm (Hani 20) and highest at 35.88 mm (Hani 58). Fruit weight was found to be lowest at 10.03 g in Hani 14 and highest at 15.46 g in Hani 59. Promising genotypes averagely changed between kernel weight of 5.00-6.77 g, kernel ratio of 41.18-53.65% and shell thickness of 1.47-2.03 mm.

Karadağ (2007), in a study that performed on some promising selected walnut genotypes, reported the average fruit weight as 10.35 g, kernel weight as 5.17 g, kernel ratio as 51.27%, shelled fruit width as 30.21 mm, shelled fruit length as 35.00 mm, shelled fruit height as 31.45 mm and shell thickness as 1.4 mm. In some other studies, Osmanoğlu and Şimşek (2010), found fruit weight to be between 10.28-14.55 g, kernel weight 5.55-7.22 g, kernel ratio 43.58-63.10% in walnut genotypes of Mazidağ (Mardin) region; Paris (2015), in promising walnut genotypes selected in Kayseri province detected fruit weight to be between 7.58-13.11 g, kernel weight 3.83-5.40 g, kernel ratio 41.21-55.91%, shell thickness 1.12-1.83 mm; Demir and et al. (2019), in Afşin (Kahramanmaraş) region selection, the fruit weight of the selected genotypes found to be between 10.11-21.53 g, kernel weight 4.62-8.38 kernel ratio 27.95-52.90%. The results in this research were mostly similar to those of previous literature in terms of shelled and kernel weight, kernel ratio and fruit sizes (width, length, height).

The lightness of the kernel fruit color is important for the quality of the kernel walnut. Light kernel color depends on genetic factors, but the relative humidity of the air ratio increases, the darkening of walnuts increases, decreases as the moisture decreases (Şen, 2011). In selected genotypes, the kernel color was evaluated as light in 6 genotypes, yellow in 9 genotypes and dark in 4 genotypes. Also, in 19 genotypes, the color of the shell was light in 13 genotypes and dark in 6 genotypes. In promising genotypes, fruit shape was found as round in 14 genotypes and oval in 5 genotypes. All genotypes were classified in “extra class “in terms of fruit size. Cracking status was evaluated as easy in 17 genotypes and medium in 2 genotypes. Kernel fullness of genotypes was detected as good in 17 genotypes, medium in 2 genotypes (Table 3) In study conduct by Muradoglu (2005), observed that kernel color yellow in 25 genotypes and dark in 25 genotypes. In another study, Kösekul (2017), reported that the color of fruit peel light yellow at 48.88% and dark-skinned at 51.11%

### Table 2. Some pomological properties of the walnut genotypes selected from Hani district

| Genotype No | Fruit weight (g) | Kernel weight (g) | Fruit width (mm) | Fruit length (mm) | Fruit height (mm) | Kernel ratio (%) | Shell thickness (mm) |
|-------------|------------------|------------------|------------------|------------------|------------------|------------------|---------------------|
| Hani 4      | 12.15            | 5.64             | 29.17            | 36.42            | 33.48            | 46.36            | 1.82                |
| Hani 7      | 10.77            | 5.19             | 29.40            | 34.56            | 30.33            | 48.24            | 1.78                |
| Hani 14     | 10.03            | 5.00             | 27.38            | 31.52            | 29.48            | 50.24            | 1.88                |
| Hani 19     | 10.15            | 5.45             | 29.73            | 36.94            | 30.48            | 53.65            | 1.47                |
| Hani 20     | 10.42            | 5.15             | 28.16            | 31.20            | 29.15            | 49.51            | 1.83                |
| Hani 32     | 10.36            | 5.06             | 30.98            | 34.48            | 29.49            | 48.78            | 1.77                |
| Hani 43     | 14.60            | 6.22             | 31.20            | 37.36            | 33.17            | 42.59            | 1.99                |
| Hani 58     | 14.17            | 6.77             | 35.04            | 50.12            | 35.88            | 47.85            | 1.58                |
| Hani 59     | 15.46            | 6.70             | 33.45            | 45.41            | 34.55            | 43.30            | 1.71                |
| Hani 64     | 11.54            | 5.23             | 32.54            | 41.64            | 32.18            | 45.34            | 1.71                |
| Hani 68     | 10.36            | 5.25             | 31.98            | 37.93            | 31.99            | 52.65            | 1.54                |
| Hani 70     | 13.28            | 6.11             | 31.96            | 37.71            | 32.85            | 45.98            | 1.89                |
| Hani 84     | 11.75            | 5.70             | 31.62            | 35.52            | 33.03            | 49.07            | 1.63                |
| Hani 85     | 11.28            | 5.90             | 31.66            | 36.59            | 31.56            | 52.29            | 2.03                |
| Hani 87     | 11.36            | 5.82             | 30.33            | 40.90            | 32.31            | 51.20            | 1.53                |
| Hani 89     | 12.95            | 6.64             | 31.20            | 36.92            | 34.40            | 51.28            | 1.69                |
| Hani 95     | 13.94            | 5.80             | 32.30            | 38.55            | 31.50            | 41.18            | 2.00                |
| Hani 105    | 10.52            | 5.08             | 27.53            | 38.63            | 29.58            | 48.78            | 1.96                |
| Hani 116    | 11.91            | 5.63             | 43.03            | 34.93            | 32.96            | 46.84            | 1.74                |
Table 3. Some fruit properties selected from Hani district

| Genotype No | Shell Color | Shell roughness | Cracking Status | Kernel Fullness | Kernel Color | Fruit Size |
|-------------|-------------|-----------------|-----------------|-----------------|--------------|------------|
| Hani 4      | Light       | Intermediate    | Easy            | Good            | Yellow       | Round Extra|
| Hani 7      | Light       | Rough           | Easy            | Good            | Light        | Round Extra|
| Hani 14     | Dark        | Smooth          | Medium          | Good            | Light        | Round Extra|
| Hani 19     | Dark        | Smooth          | Easy            | Good            | Yellow       | Round Extra|
| Hani 20     | Light       | Smooth          | Easy            | Good            | Light        | Round Ekstra|
| Hani 32     | Light       | Rough           | Easy            | Good            | Light        | Round Extra|
| Hani 43     | Dark        | Intermediate    | Medium          | Good            | Light        | Round Extra|
| Hani 58     | Light       | Intermediate    | Easy            | Good            | Dark         | Oval Extra  |
| Hani 59     | Dark        | Rough           | Easy            | Good            | Yellow       | Oval Extra  |
| Hani 64     | Light       | Intermediate    | Easy            | Good            | Dark         | Oval Extra  |
| Hani 68     | Dark        | Intermediate    | Easy            | Good            | Yellow       | Round Extra|
| Hani 70     | Light       | Rough           | Easy            | Good            | Dark         | Round Ekstra|
| Hani 84     | Light       | Rough           | Easy            | Good            | Light        | Round Extra|
| Hani 85     | Light       | Rough           | Easy            | Good            | Dark         | Round Ekstra|
| Hani 87     | Light       | Intermediate    | Easy            | Good            | Yellow       | Oval Extra  |
| Hani 89     | Dark        | Rough           | Easy            | Good            | Yellow       | Round Extra|
| Hani 95     | Light       | Rough           | Easy            | Good            | Yellow       | Round Extra|
| Hani 105    | Light       | Rough           | Easy            | Medium          | Yellow       | Oval Extra  |
| Hani 116    | Light       | Smooth          | Easy            | Good            | Yellow       | Round Extra|

Table 4. Phenological characteristics and harvest dates of promising genotypes

| Genotype No | First leaf initiation date | Male flowering date | Female flowering date | Dicogamy flowering date | Fruit yield in lateral branches (%) | Harvest time |
|-------------|-----------------------------|---------------------|-----------------------|-------------------------|--------------------------------------|--------------|
| Hani 4      | 18-20 April                 | 26-28 April         | 1-3 May               | Protandrous             | 50                                   | 21-22 September|
| Hani 7      | 17-19 April                 | 23-25 April         | 1-2 May               | Protandrous             | 60                                   | 23-25 September|
| Hani 14     | 16-18 April                 | 24-26 April         | 3-5 May               | Protandrous             | 70                                   | 23-25 September|
| Hani 19     | 25-27 April                 | 5-7 May             | 8-10 May              | Protandrous             | 20                                   | 28-29 September|
| Hani 20     | 18-20 April                 | 24-26 April         | 27-29 April           | Protandrous             | 0                                    | 23-25 September|
| Hani 32     | 27-29 April                 | 5-7 May             | 6-8 May               | Protandrous             | 50                                   | 28-29 September|
| Hani 43     | 16-18 April                 | 25-27 April         | 4-6 May               | Protandrous             | 40                                   | 21-22 September|
| Hani 58     | 26-28 April                 | 1-3 May             | 1-3 May               | Homogamous              | 40                                   | 28-29 September|
| Hani 59     | 21-23 April                 | 28-30 April         | 1-2 May               | Protandrous             | 30                                   | 21-22 September|
| Hani 64     | 24-26 April                 | 7-9 May             | 3-5 May               | Protogynous             | 40                                   | 28-29 September|
| Hani 68     | 23-25 April                 | 1-3 May             | 1-3 May               | Homogamous              | 50                                   | 21-22 September|
| Hani 70     | 21-23 April                 | 28-30 April         | 1-3 May               | Protandrous             | 30                                   | 21-22 September|
| Hani 84     | 20-22 April                 | 28-30 April         | 1-3 May               | Protandrous             | 60                                   | 23-24 September|
| Hani 85     | 21-23 April                 | 28-30 April         | 1-2 May               | Protandrous             | 70                                   | 23-24 September|
| Hani 87     | 21-23 April                 | 1-3 May             | 1-3 May               | Homogamous              | 40                                   | 23-24 September|
| Hani 89     | 21-23 April                 | 1-2 May             | 3-5 May               | Protandrous             | 50                                   | 23-24 September|
| Hani 95     | 24-26 April                 | 1-2 May             | 1-2 May               | Homogamous              | 100                                  | 28-29 September|
| Hani 105    | 22-24 April                 | 1-2 May             | 3-4 May               | Protandrous             | 60                                   | 23-24 September|
| Hani 116    | 16-18 April                 | 23-25 April         | 27-29 April           | Protandrous             | 60                                   | 19-20 September|
Phenological properties of promising genotypes were given in Table 5. According to Table 5, it was recorded that first leaf initiation date, male flowering date, female flowering date, dichogamy flowering state, lateral fruitfulness (%) and harvest time of promising genotypes changed between 16-29 April, 23 April and 9 May, 27 April and 10 May, 0-100% and 21-29 September, respectively (Table 4). Şimşek and Osmanoğlu (2010) determined that the flowering state of genotypes was found to be 50.00% protandrous, 33.33% protogynous and 16.16% homogamous. Gülsoy et al. (2016), reported that in selected genotypes, protandrous, protogynous and homogamous were 11, 9 and 1 respectively in terms of flowering stage Yıldız (2016), informed that percentages of fruit yield in lateral branches of selected genotypes were observed between 30 % and 80 %. In walnut varieties and genotypes, it is reported that flowering dates, the tendency of dichogamy, lateral fruitfulness depend on climate conditions, altitude, planting direction, plant age, and the genetic structure (Şen, 1980; Akça, 2009; Balık and Beyhan 2011; Sütyemez et al., 2018).

Conclusion
As a result, very valuable walnut genotypes were identified in the natural walnut population in the Hani district of Diyarbakır, where no previous studies were conducted on walnut selection. In the study, especially Hani 59, Hani 43 and Hani 58 with high shelled fruit weight (over 14 g), and Hani 58, Hani 59 and Hani 89 with high kernel weight (over 6.5 g) attracted attention. It is also thought that these promising genotypes can be cultivar candidates. Besides, these genotypes should be done of the adaptations in the same ecological conditions with domestic and foreign standard walnut varieties. Afterward, the prominent genotypes can be produced as economical and grafted onto suitable rootstocks. In this way, it is thought to contribute to both regional producers and walnut production in our country.

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