Journal of the American Pomological Society 67(3): 175-181 2013

Two new sweet chestnut cultivars from the Anatolian region: 'Unal' and 'Erfelek'

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Additional index words: cultivar registration, nut crops, pomology, Turkey

Abstract

The European chestnut (*Castanea sativa* Mill.), which is native to the Black Sea, Marmara and Aegean Regions of Turkey, plays an important role in both forests and orchards of Asia Minor (Anatolia). In orchard plantings, it is preferable to establish selections with improved traits. The aim of our work was to study the morphological and phenological characteristics of the selections 'Unal' (SE 3-12) and 'Erfelek' (SE 21-9) from the Black Sea Region and to register them as new cultivars for potential orchard plantings. Morphological characteristics such as tree vigor and growth habit, shoot, leaf, flower, bur and fruit characteristics, and phenological characteristics such as time of bud break, flowering, nut ripening and leaf fall of these cultivars were studied on 9-year-old trees for three growing seasons (2006-2008). Both cultivars had a similar tree vigor and growth habit. 'Unal' had dense but thinner and shorter lateral shoots and longer leaf lamina and petioles, but lower individual leaf area than 'Erfelek'. 'Erfelek' started to break bud, bloom and ripen two weeks earlier than 'Unal'. Both cultivars had small but very bright, dark brown, highly acceptable fruits with light cream kernels. The seed coat on fresh fruit peeled easily and didn't penetrate into the kernel in either cultivar. Both 'Unal' and 'Erfelek' have been registered as new cultivars.

The European chestnut (*Castanea sativa* Mill.), also known as sweet chestnut, is native to humid, temperate regions around the Mediterranean, primarily southern Europe and Asia Minor and particularly to the Black Sea, Marmara and Aegean Regions of Turkey (Davis, 1982; Soylu, 2004). In these areas, the chestnut has a history of cultivation dating back to the time of the Roman Empire (Miller, 2003). There are about 2.5 million chestnut trees in Turkey and annual chestnut production is about 60,000 tonnes.

The Marmara region has the oldest and richest chestnut culture. Many chestnut cultivars have been grown in this region for centuries (Soylu, 2004). There are also some local chestnut cultivars in the Aegean region where grafted trees are the preferred means of cultivation (Ertan et al., 2007; Koyuncu et al., 2008). In contrast, seedling trees are generally used for chestnut production in the Black Sea Region.

Chestnut selection studies were conducted to determine superior genotypes in terms of yield and quality in the region (Ayfer et al., 1982; Serdar, 1999; Serdar and Soylu, 1999; Serdar, 2002; Yarilgac et al., 2009). The genotypes SE 3-12 and SE 21-9 were selected from the Sinop province in the Black Sea Region in 1992 as chance seedlings (Serdar and Bilgener, 1995; Serdar, 1999). These genotypes were propagated by grafting and planted (7 x 7 m tree spacing) in an experimental orchard in Ordu in 1997. Yield and fruit characteristics of the genotypes were examined from 1997 to 2005. Both genotypes were determined to be potential cultivar candidates and were named 'Unal' (SE 3-12) and 'Erfelek' (SE 21-9) in 2005. This study was carried out to define the morphological and phenological characteristics of these two potential cultivar candidates in order to achieve their registration.

Materials and Methods

This study was carried out on the two

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cultivars 'Unal' and 'Erfelek' over three years from 2006 to 2008. The experimental orchard was located in the Ordu province (40°58'38"N and 37°36'35"E, 240 m a.s.l.) in the Black Sea Region. The climate of the area was characterized by an annual mean temperature of 14.3ºC, and a total rainfall of 1047.4 mm (Turkish State Meteorological Service, 2011). The soil was a clay loam with 1.14% organic matter and a pH of 5.75.

To determine the morphological and phenological characteristics of 'Unal' and 'Erfelek', measurements and observations were made of lateral shoots, flowers, leaves, burs, and fruit. Tree vigor, growth habit, shoot density, and shoot color were determined. Also, lateral shoot thickness, length of internodes, and lenticel density on lateral shoots were investigated in February. The form of the male catkin, length of stamen filaments, and the lengths of both male and mixed catkins were investigated on the flowers at time of flowering. The shape of the leaf tip, incisions in the leaf margin ("serrations"), and leaf dimensions were determined in August. Leaf area was determined according to Serdar and Demirsoy (2006), and ratios of lamina width/length, lamina width/leaf length and seration width/length were calculated. The size and shape of the burs, and length and density of spines, were investigated on samples taken just before the cracking of the bur. Fruit size and shape, hilum size and shape, brightness and color of the pericarp and kernel, density of tomenta on the fruit tip, splitting of pericarp, ease of peeling of the seed coat, degree of penetration of the seed coat into the embryo, and polyembryony were all measured. The sweetness of the nuts and the presence of stripes on the nut surface were investigated using freshly harvested fruit.

The same three trees per genotype were sampled in each of the three years of the study and 15 samples per tree were examined for each quantitative characteristic. Samples were pooled each year and a standard error was determined to define the overall variability for each set of observations. Phenological observations were recorded once or twice a week and mean values of data from the three years were calculated. Descriptions of tree, leaf, flower, bur and fruit characteristics were made according to Serdar et al. (2011a).

An application for cultivar registration of these chestnut cultivar candidates was made to the Turkey Variety Registration and Seed Certification Centre (TTSM) in 2005. Further evaluations of their characteristics were made by the TTSM during 2006-2008.

Results

Both cultivars were vigorous and semi-upright trees (Table 1). 'Unal' had a higher shoot density, but thinner and shorter lateral shoots than 'Erfelek'. 'Unal' started to break bud, bloom and ripen two weeks later than 'Erfelek' (Table 2). However, the timing of leaf fall was similar in both cultivars.

'Unal' had longer leaf laminas and petioles but smaller leaves than 'Erfelek' (Table 3, Figs. 1, 2). Ratios of lamina width/length, lamina width/ leaf length and serration width/ length were also lower in 'Unal' than 'Erfelek'.

Table 1. Tree and shoot characteristics of 'Unal' and 'Erfelek'.

Tree and shoot characteristics	Unal	Erfelek
Tree vigor	Vigorous	Vigorous
Growth habit	Semi-upright	Semi-upright
Shoot density	High	Intermediate
Color of shoot	Brown	Brown
Thickness of lateral shoot (mm)	Thin (5.30 $\pm$ 0.18)	Intermediate (5.92 $\pm$ 0.21)
Length of internodes of lateral shoot (mm)	Short (29.6 $\pm$ 0.96)	Intermediate (33.3 $\pm$ 1.17)
Lenticel density of lateral shoot (no. per cm^2)	Sparse (21.5 $\pm$ 0.79)	Intermediate (25.9 $\pm$ 0.85)

Table 2. Phenological characteristics of ‘Unal’ and ‘Erfelek’.

Phenological characteristics	Unal	Erfelek
Time of bud break	Very late (17 Apr.- 4 May)	Intermediate (5-23 April)
Start of flowering of male catkins	Very late (10-15 June)	Intermediate (1-8 June)
Start of flowering of female catkins	Very late (9-23 June)	Intermediate (1-17 June)
Ripening time	Very late (16-19 October)	Intermediate (3-11 Oct.)
Time of leaf fall	Intermediate (28 Nov.- 10 Dec.)	Intermediate (25 Nov.- 5 Dec.)

Table 3. Leaf characteristics of ‘Unal’ and ‘Erfelek’.

Leaf characteristics	Unal	Erfelek
Shape of leaf tip	Aristate	Acuminate
Incisions of margin (habit of teeth)	Dentate	Mucronate
Leaf area, leaf size (cm^2)	Small (72.5 ± 3.36)	Intermediate (93.5 ± 3.52)
Lamina width (cm)	Short (4.33 ± 0.13)	Large (6.26 ± 0.15)
Lamina length (cm)	Long (22.4 ± 0.50)	Intermediate (21.2 ± 0.38)
Leaf length (cm)	Long (25.1 ± 0.51)	Intermediate (23.1 ± 0.40)
Petiole length (mm)	Long (26.3 ± 0.51)	Short (18.8 ± 0.42)
Ratio of lamina width/lamina length	Small (0.19 ± 0.006)	Large (0.30 ± 0.001)
Ratio of lamina width/leaf length	Small (0.17 ± 0.006)	Large (0.27 ± 0.001)
Ratio of teeth width/teeth length	Small (0.26 ± 0.05)	Intermediate (0.39 ± 0.09)

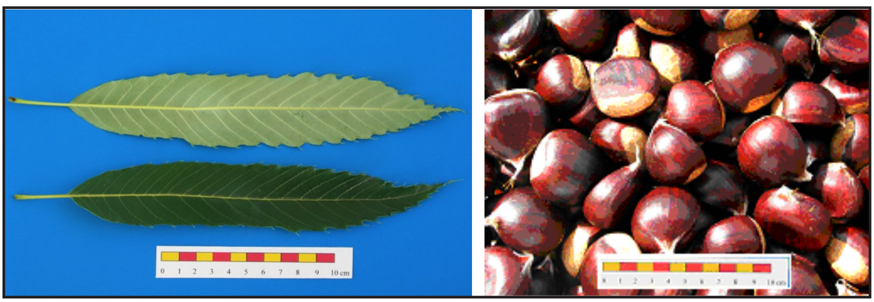

Fig. 1. 'Unal': leaves and fruits (striped bar = 10 cm length).

Fig. 2. 'Erfelek': leaves and fruits (striped bar = 10 cm length).

'Erfelek' had longer catkins but both cultivars had long stamens (Table 4).

Bur shapes of 'Unal' were globular while those of 'Erfelek' were squarely globular. 'Unal' had longer spines on the bur and a higher spine density than 'Erfelek' (Table 5). 'Unal' had ovoid fruits while 'Erfelek' had transverse broad ellipsoid fruits. Both cultivars had small but very bright, dark brown and highly acceptable fruits with light cream kernels. Peeling of the seed coat from fresh fruit was easy and the seed coat did not penetrate into the kernel in either cultivar (Table 6).

As result of this study, both 'Unal' and 'Erfelek' were registered as new European chest-

Table 4. Flower characteristics of 'Unal' and 'Erfelek'.

Flower characteristics	Unal	Erfelek
Form of male catkin	Intermediate	Intermediate
Length of stamen filament in male catkin (mm)	Longistaminate (7.59 ± 0.2)	Longistaminate (6.34 ± 0.2)
Length of male catkin (cm)	Intermediate (17.0 ± 0.4)	Long (22.3 ± 0.5)
Length of mixed catkin (cm)	Intermediate (10.3 ± 0.8)	Long (13.7 ± 0.7)

Table 5. Bur characteristics of 'Unal' and 'Erfelek'.

Bur characteristics	Unal	Erfelek
Shape of bur	Globular	Squarely globular
Length of spine (mm)	Intermediate (17.6 ± 0.3)	Short (13.4 ± 0.3)
Density of spine (number per cm^2)	High (320.4 ± 15)	Low (174.3 ± 11)
Size of bur*	Small (5085 ± 76)	Small (5264 ± 101)

*Size of bur: bur width x bur length

Table 6. Fruit characteristics of 'Unal' and 'Erfelek'.

Fruit characteristics	Unal	Erfelek
Fruit shape*	Ovoid (99 ± 2.0)	Transverse broad ellipsoid (111 ± 2.7)
Relative size of hilum in relation to fruit**	Small (0.46 ± 0.01)	Small (0.45 ± 0.02)
Brightness of pericarp	Very bright	Very bright
Colour of pericarp	Dark brown	Dark brown
Density of tomenta on fruit tip	Low	Low
Chestnuts with a split pericarp (%)	Low (3.2 ± 0.7)	Low (0.6 ± 0.2)
Size of fruit	Small (112 ± 2.9 nuts/kg)	Small (111 ± 2.5 nuts/kg)
Color of kernel	Light cream	Light cream
Peeling of seed coat in fresh fruit	Very easy	Very easy
Penetration of seed coat into the embryo	No penetration	No penetration
Polyembryony (%)	Intermediate (6.4 ± 3.4)	Low (3.4 ± 1.5)
Sweetness	Delicious	Delicious
Hilum size***	Small (225 ± 9.5)	Small (241 ± 15.9)
Shape of hilum****	Elliptical medium (2.0 ± 0.08)	Elliptical long (2.3 ± 0.09)
Nut stripes	Exist	Exist

*Fruit shape: chestnut length/ chestnut width x 100
**Relative size of hilum in relation to fruit : hilum width x hilum length /fruit length x fruit thickness
***Hilum size: hilum width x hilum length
****Shape of hilum: hilum length / hilum width

nut cultivars by the Turkey Variety Registration and Seed Certification Centre in 2009.

Discussion

Fruit sizes of these cultivars are larger than both 'Ersinop' and 'Eryayla' (Serdar et al., 2011b) but smaller than 'Marigoule' (Serdar et al., 2011a). Cumulative yields of these cultivars were compared with some genotypes and cultivars such as SA 5-1, SE 18-2, 'Ersinop', 'Eryayla' and 'Salipazari' in both the Ordu and Samsun provinces (Serdar et al., 2009). The highest cumulative yield was obtained from 'Unal' in Samsun. Chestnut cultivars investigated in that study had higher yields in Samsun where the growing site had a slight slope and better soil characteristics than in Ordu. In a related study (Serdar et al., 2011a), 'Unal' and 'Erfelek' had lower yields than 'Serdar' and 'Marigoule'. Hence the yield of 'Unal' varied across different locations but it may have more yield potential than 'Erfelek' in suitable sites.

An inverse ratio between the density of spines and infestation of chestnut weevil has been determined in chestnut (Webster, 1975) and, consistent with the morphological characteristics that were defined, Tuncer and Serdar (1996) found that susceptibility to chestnut weevils was lower in 'Unal' (3.1%) than in 'Erfelek' (22.9%).

Genetic polymorphism based on morphological criteria and RAPD markers of these cultivars have been determined previously and they were placed in different main groups (Serdar et al., 2014). However, more detailed genetic studies, such as those using SSRs and SNPS, would be helpful in defining the genotypes more precisely.

Chestnut growing is carried out with seedling trees in natural forest areas in the Black Sea Region. However, some genotypes or local cultivars such as 'Salipazari' (554-14) and 'Altinay' (SA 5-1) are propagated using grafting. Over recent decades, chestnut blight (*Crphonectria parasitica*) has caused considerable damage to chestnut forests and the unregistered selection 'Salipazari', which is a common local chestnut cultivar in Samsun province, has not been officially registered because of its susceptibility to chestnut blight. Both 'Unal' and 'Erfelek' had lower susceptibility to chestnut blight than some other genotypes such as 'Altinay' (Erper et al., 2004) and are becoming increasingly common in the Sinop province. 'Altinay' is a local cultivar grown in the Sinop province (Serdar, 1999) but it has never been registered due to questions regarding its graft incompatibility as well as its susceptibility to chestnut blight.

In recent years, some recovery within trees has begun within the forests and some hypovirulent strains of the blight have been found (Akilli et al., 2009a; 2009b; 2011). The Forest Ministry of Turkey is now avoiding the use of introduced genetic material (species or hybrids) in the forested areas. Since both 'Unal' and 'Erfelek' represent improved selections of European sweet chestnut, planting these cultivars would not be in conflict with the policies of the Ministry.

'Unal' and 'Erfelek' may achieve considerable importance in the Black Sea Region where the quality of chestnut is especially characterized by ease of peeling and taste. In this region there is a belief that as the fruit size of the chestnut increases, it loses flavor. Hence cultivars with small fruits are preferred by consumers in this part of Turkey. Sweet chestnuts from this region are also very popular for roasting. Consequently, these genotypes are being rapidly propagated by grafting onto wild trees of chestnut in the Sinop province.

New chestnut orchards have recently been established in Turkey and, in this respect, 'Marigoule' has been the preferred cultivar because it is more tolerant to chestnut blight and drought, and it also ripens early (Serdar et al., 2012). Chestnut trees require cross fertilization because of self incompatibility (Soylu and Ayfer, 1981; Anagnostakis, 2012). Consequently, pollenizer cultivars should be used in the establishment of chestnut orchards and should bloom at the same time as the main fruiting cultivars, have a large number of male catkins, stamens and fertile pollen, and also have high quality fruits and yield. 'Erfelek' has been shown to be an important pollinizer for 'Marigoule' (Serdar et al., 2010).

Chestnut is also important for chestnut honey production, especially in the Black Sea and Marmara Regions, where growers get income from honey production. The cultivar 'Serdar' is very important for honey production in the forest areas since it blooms twice in the growing season, firstly in June and then in August-September (Serdar and Soylu, 2005; Serdar et al., 2011a). 'Unal' can be used also as pollenizer for 'Serdar' (Serdar et al., 2010). Due to the unique characteristics of the potential cultivars reported here, we strongly believe that both 'Unal' and 'Erfelek' should be recommended as main cultivars to the forest areas of the Black Sea Region, or as pollenizers for 'Serdar' and 'Marigoule', respectively.

Acknowledgements

This study was supported by The Scientific and Technological Research Council of Turkey (TUBITAK), Project No: TOVAG-105O073. We also thank Ismet Unal and Serafettin Unal and all of the members of their family for providing the opportunity to use the experiment orchard and for their hospitality. We'd also like to thank all of our colleagues in the Horticultural Department of Ondokuz Mayis University for assistance in these studies.

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How does simulated frost treatment affect peach [*Prunus persica* (L.)] flowers of different cultivars from worldwide breeding programmes?

The proportion of frost damaged flowers (FD) and frost symptoms (S1, S2, S3 and S4) was evaluated on 56 peach cultivars from several breeding programmes during 2010 and 2011 seasons in order to understand the tolerance of peach cultivars to low temperature and the susceptibility of their pistils to frost damage. The cultivars were tested at full bloom ('F') under simulated frost treatment. Fifteen of these cultivars were also selected in 2012 to calculate frost temperatures (FT_{10}, FT_{50} and FT_{90}) and their relationship to pistil dry matter. Mid blooming cultivars showed lower tolerances to low temperature than late and early blooming cultivars. Their pistils were also more susceptible to low temperature, showing a higher proportion of more severe symptoms. Blooming time did not affect the degree of pistil susceptibility. Fruit type or peach subspecies (peach, nectarine and flat peach) showed similar susceptibilities to low temperatures; this was not, however, the case for pistils. Significant differences in FD were found for nectarine breeding programmes, but not for peach breeding programmes. The PSB nectarine breeding programme included most of the hardiest cultivars. The susceptibility of pistils to frost damage varied according to breeding programme. Great variability and significant differences were observed between cultivars with regard to FD and frost symptoms. The three frost temperatures considered in this study (FT_{10}, FT_{50} and FT_{90}) corroborated this variability, mainly because significant differences between cultivars were found within each frost temperature. Nevertheless, no significant relationship was found between them and pistil dry matter. These results provide growers with important information to help them when selecting cultivars for new orchards. Abstract from: G. Reig, I. Iglesias, C. Miranda, F. Gatius, and S. Alegre. Scientia Horticulturae 160:70-77.