

Morphological and Phenological Characteristics of Ersinop and Eryayla Chestnut Cultivars

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Abstract: In order to verify the plant characteristics of Ersinop and Eryayla, new earliness sweet chestnut cultivars from the Black Sea Region, Turkey by comparing the standard cultivar (cv.) Marigoule, some morphological and phenological characteristics of them were evaluated. For this aim, tree vigor and growth habit, shoot, leaf, flower, bur and fruit characteristics, time of bud burst, flowering, ripening and leaf fall were investigated. Three trees per genotype and 10-50 plant material per tree were sampled for the each quantitative characteristic; so 30-150 measurements were done. Ersinop and Eryayla chestnut cultivars (*Castanea sativa* Mill.) were released for earliness. Nuts of them ripened in the second and third week of September, respectively. They had tasteful fruits. Peeling of seed coat of them was easier than Marigoule. However, fruit sizes of them were smaller than Marigoule (respectively 5.9, 4.8 and 16.3 g). Penetration of seed coat into the embryo was absent in Ersinop and Eryayla cultivars and lower (= 2 mm) in Marigoule. Ersinop and Eryayla cultivars had vigorous trees and semi-upright growth habit like as Marigoule. These cultivars had thicker lateral shoots and longer internodes than Marigoule. Bud burst was earlier 4-5 days in Ersinop. However Eryayla started to bloom 6-10 days earlier than the other cultivars. Ersinop and Eryayla cultivars had mucronate teeth unlike Marigoule. Eryayla had bigger leaves which had longer and wider lamina. Habit of male catkin was spreading in Ersinop, upright in Eryayla and intermediate in Marigoule. All of them had longistaminate stament filament. However Eryayla cv. had short male and mixed catkins. It can be concluded from the results of this study that Ersinop and Eryayla are earliness cultivars and they have easy peeling and tasteful kernels for consumption. They can be advised for establishing new chestnut orchards.

Key words: Chestnut • Cultivar • Earliness • Turkey • Variety registration • Cultivar releasing

INTRODUCTION

Anatolia is one of the original centers of chestnut (*C. sativa* Mill.). There are about 2394000 chestnut trees in Turkey [1] and chestnut production was 61 697 tons in 2009 [2]. Since chestnut growing in Anatolia (Turkey) dates back to ancient times, numerous chestnut genotypes with different tree characteristics and fruit quality have emerged. This is evident from the chestnuts sold in local markets. These chestnuts vary in terms of taste, color, shape and peeling [3,4]. The existence of thousands of different genotypes in nature is desirable for breeding, since these are ready to use individuals, hybridized readily in nature and well adapted to different soils and climates. Plant breeders select and vegetatively propagate the genotypes with high yielding potential [4]. Thus, chestnut selection studies have been performed to determine the superior genotypes in terms of yield and quality in these regions of Turkey [5-13].

Chestnut growing areas in Turkey are spread from the Eastern Black Sea Region, through to Marmara and the Aegean Regions and then reached to Antalya in the Mediterranean Region in Anatolia. The Black Sea Region has 35.2 % of the total number of chestnut trees in Turkey and 29.4 % of the total chestnut production in Turkey [14]. Chestnut genotypes of the Black Sea Region of Turkey are characterized by easy peeling and delicious but small fruits compared to genotypes grown in the Marmara and Aegean Regions. Chestnuts grown in this region are very popular for especially fresh consumption. Ersinop and Eryayla cultivars are the SE 21-2 and 552-8 chestnut genotypes, respectively selected from this region for earliness [9,10]. The aim of the study reported here was to verify the morphological and phenological characteristics of these cultivars which may have potential in improving chestnut production and quality in this region.

MATERIALS AND METHODS

Material Background: SE 21-2 and 552-8 and chance seedlings, are the chestnut genotypes selected from the Black Sea Region in 1992 and 1996, respectively [9,10]. Process after selection up to variety registration was carried out from 1992 to 2005. For this purpose, the grafted plants of these genotypes were planted in the trial orchard in Middle Black Sea Region in 1998. In the trial orchard, 10 promising genotypes [9,10] from Middle Black Sea Region were evaluated. Preliminary results for especially the years to bearing, plant growth and some pomological and phenological traits under the same ecological conditions have been reported [15]. The yield and some fruit traits of the genotypes were determined in 2000-2005. Finally, five genotypes (SE 3-12, SE 21-2, SE 21-9, 552-8 and 556-8) were selected as candidates for variety registration in 2005 [14]. SE 21-2 and 552-8 genotypes were selected for earliness in fresh consumption. An application for variety registration for these genotypes was made to Turkey Variety Registration and Seed Certification Centre (TTSM) in 2005. Further evaluations of all characteristics of the genotypes were also determined and this procedure was checked by TTSM in 2006-2008. These genotypes were registered as Ersinop and Eryayla cultivars, respectively in the name of Agricultural Faculty of Ondokuz Mayıs University.

Experimental Area: This research was carried out in 2006-2008 in an orchard established with 10 promising genotypes (7 x 7 m) in Fatsa/Ordu in 1998. Marigoule (an European x Japanese hybrid cultivar) planted in 2000 was used as standard cultivar. This place is located in the North of Turkey (40°58'38"N and 37°36'35"E, 240 m a.s.l.) in the Middle Black Sea Region. According to data (mean of 1975-2008) obtained from Turkish State Meteorological Service [16], the climate of the area is characterized by annual mean temperature of 14.3°C and total rainfall of 1047.4 mm. The soil was clay loam with 1.14 % organic matter and 5.75 of pH.

Collection of Samples: Tree vigour and growth habit were evaluated by observing height of tree, width of tree crown and area occupied by tree crown after leaf fall [17,18]. Shoot density and color of shoot were determined according to Kotobuki [17]. Lateral shoot examples were taken in February of each year. Ten shoots per tree and three trees per genotype were sampled. Thickness of lateral shoot (at the middle of the shoot), internode lengths and number of lenticels per cm² (between 3rd-5th internodes in the base of shoot) were determined.

Measurements for internode lengths were done on 5 internodes in the middle part of shoot [18].

Leaf samples were taken from 5th-7th nodes in well developed lateral shoots in the second week of August of each year. Ten leaves per tree and three trees per genotype were sampled. Shape of leaf tip was determined according to Kotobuki [17]. Incisions of margin were determined according to UPOV [18]. Leaf width was measured in the middle of the leaf lamina length. Length and width of the teeth were measured in the middle part of leaf. Two measurements were done for these traits per leaf. Ratios of lamina width/lamina length, lamina width/leaf length and teeth width/teeth length were calculated. Leaf area (leaf size) was determined according to Serdar and Demirsoy [19]. Habit of male catkin was determined in fully blooming time according to Kotobuki [17]. Flower catkin samples were also taken in this time. Lengths of stamen, length of male and mixed catkins were determined. For each trait, 30 measurements were done.

Bur samples which contain three fruits were taken from genotypes just before cracking. Ten burs per tree and three trees per genotype were sampled. Length and width of the burs were measured. Bur size was calculated by multiplying length and width of the bur. Density of spine was measured at 1 cm² samples taken from lateral part of the burs. Length of spine was measured also in these samples [20].

Fruit samples were taken after cracking of bur and seeing of nuts having original colour. Fifty fruits per tree and three trees per genotype were sampled. Chestnuts with a split pericarp (%) were determined according to Furones-Perez and Fernandez-Lopez [20]. Brightness of fruit and kernel colour was examined by using three state of scala. Colour of fruit was evaluated according to UPOV [18]. Fruit size was determined by counting the fruits in a kilogram and polyembryony was determined by dividing of number of fruits including double or more embryos in a kernel to total number of studied fruits. These characteristics were classified according to Bounous *et al.* [21]. For fruit and hilum shape, lateral fruits in the bur including three nuts were used. Fruit and hilum shapes and hilum size were determined according to Furones-Perez and Fernandez-Lopez [20]. Relative size of hilum in relation to the hilum part of fruit was determined by calculating the ratio of hilum length x hilum width to fruit length x fruit thickness. Density of tomenta on fruit tip was determined according to Kotobuki [17]. Nut stripes were determined according to Bounous *et al.* [21].

Phenological observations of three trees per genotype were recorded once or twice a week. Mean values were calculated for each parameter for 3 trial years (2006-2008).

Table 1: Description of tree, leaf, flower, bur and fruit for chestnut

Descriptor name	Scala
Tree and shoot characteristics	
Tree vigor	Very weak, weak, intermediate, vigorous, very vigorous
Growth habit	Erect, semi upright, spreading
Shoot density	Low, intermediate, high
Color of shoot	Grayish yellow, yellow, yellowish brown, light brown, brown, reddish brown
Thickness of lateral shoot (mm)	Thin (= 5.63 mm), intermediate (5.64-5.99 mm), thick (= 6 mm)
Length of internodes of lateral shoot (mm)	Short (= 29.7mm), intermediate (29.8-33.7 mm), Long (= 33.8 mm)
Lenticel density of lateral shoot (no. per cm ²)	Sparse (= 25.1), intermediate(25.2-29.8), dense (29.9)
Phenological characteristics	
Time of leaf bud burst	Very early (Before or on 1 April), early (Between 2-5 April), intermediate (Between 6-9 April), late (Between 10-13 April), very late (Later than 14 April)
Beginning to bloom of male catkins	Very early (Before or on 28 May), early (Between 29-31 May), intermediate (Between 1-3 June), late (Between 4-6 June), very late (Later than 7June)
Beginning to bloom of female catkins	Very early (Before or on 28 May), early (Between 29-31 May), intermediate (Between 1-3 June), late (Between 4-6 June), very late (Later than 7June)
Ripening time	Very early (Before or on 15 September), early (Between 16-24 September), intermediate (Between 25 September-3 October), late (Between 4-12 October), very late (Later than 13 October)
Time of leaf fall	Early (Before or on 24 November), intermediate (Between 25-28 November), late (Later than 29 November)
Leaf characteristics	
Shape of leaf tip	Aristate, attenuate acuminate, acuminate, acute
Incisions of margin (habit of teeth)	Mucronate, dentate
Leaf area, leaf size (cm ²)	Small (=85.6), intermediate (85.7-98.8), large (=98.9)
Lamina width (cm)	Short (=5.10), intermediate (5.11-5.88), large (=5.89)
Lamina length (cm)	Short (=20.4), intermediate (20.5-22.0), long (=22.1)
Leaf length (cm)	Short (= 22.5), intermediate (22.6-24.1), long (= 24.2)
Petiole length (mm)	Short (= 21.4), intermediate (21.5-24.1), long (= 24.2)
Ratio of lamina width/lamina length	Small (= 0.23), intermediate (0.24-0.26), large (=0.27)
Ratio of lamina width/leaf length	Small (= 0.20), intermediate (0.21-0.24), large (= 0.25)
Ratio of teeth width/teeth length	Small (= 0.32), intermediate (0.33-0.43), large (= 0.44)
Flower characteristics	
Habit of male catkin	Upright, intermediate, spreading
Length of stamen filament in male catkin (mm)	Astaminate (no filament), brachystaminate (1-3 mm), mesostaminate (3-5 mm), longistaminate (5-7 mm)
Length of male catkin (cm)	Short (=14.4), intermediate (14.5-18.6), long (= 18.7)
Length of mixed catkin (cm)	Short (= 9.2), intermediate (9.3-12.5), long (=12.6)
Bur characteristics	
Shape of bur	Globular, flat globular, squarely globular
Length of spine (mm)	Short (= 15.4), intermediate (15.5-19.5), long (= 19.6)
Density of spines (number. per cm ²)	Low (=180), intermediate (181-242), high (= 243)
Size of bur	Small (= 5544), intermediate (5545-7500), large (= 7501)
Fruit characteristics	
Fruit shape	Ovoid (<100), broad ovoid (101-109), globose (100), transverse ellipsoid (>120), transverse broad ellipsoid (110-120)
Relative size of hilum in relation to fruit	Small (= 0.59), intermediate (0.60-0.73), large (= 0.74)
Brightness of pericarp	Absent, bright, very bright
Color of pericarp	Light brown, brown, dark brown, reddish brown, blackish brown
Density of tomenta on fruit tip	Low, intermediate, high
Chestnuts with a split pericarp (%)	Low (<15), intermediate (15-29.9), high (= 30)
Fruit size	Very small (=121 nuts/kg), small (101-120 nuts/kg), intermediate (81-100 nuts/kg), big (61-80 nuts/kg), very big (= 60 nuts/kg)
Color of kernel	Light cream, cream, dark cream
Peeling of seed coat in fresh fruit	Very easy, easy, intermediate, difficult
Penetration of seed coat into the embryo	No penetration, weak penetration (visible = 2 mm), strong penetration (visible ? 2.0 mm)
Polyembryony (%)	Absent, Low (1-4), intermediate (5-8), high (8-12), very high (= 12.1)
Sweetness	Poor:1, intermediate: 4, good: 7, tasteful: 10
Hilum size	Small (= 348), intermediate (349-521), large (= 522)
Shape of hilum	Elliptical broad (= 1.8), elliptical medium (1.9-2.1), elliptical long (= 2.2)
Nut stripes	Absent, Exist

Classification of Characteristics: For the evaluation of distinctness, uniformity and stability (DUS) of chestnut plant material of Unal cv., morphological and phenological characteristics are classified according to The International Union for the Protection of New Varieties of Plants (UPOV) descriptors [18]. And also, some new and more useful descriptors improved for chestnut [17,18,20,22] were used.

Values of classification of phenological characteristics and also quantitative traits such as shoot, leaf and flower etc. were done with respect to our five candidate genotypes (SE 3-12, SE 21-2, SE 21-9, 552-8 and 556-8) for variety registration and Marigoule cv. studied in ecological conditions of the Middle Black Sea Region. The ranges of values for a class state were calculated by dividing the difference between the maximum and minimum values by number of class. It was used scales of Furones-Perez and Fernandez-Lopez [20] for length of stamen filament in male catkin and chestnuts with a split

pericarp, fruit and hilum shape and degree of penetration of seed coat into the embryo and scala of Serdar and Soyly [15] for sweetness. Description of tree, leaf, flower, bur and fruit was made according to Table 1 based on data of UPOV [18], Kotobuki [17], Serdar and Soyly [15], Furones-Perez and Fernandez-Lopez [20] and Serdar *et al.* [14].

RESULTS AND DISCUSSION

Ersinop and Eryayla cultivars had vigorous trees and semi-upright growth habit like as Marigoule (Table 2). Eryayla had higher shoot density than Ersinop and Marigoule cultivars. Colour of shoot was light brown in Ersinop, brown in Eryayla and reddish brown in Marigoule. Ersinop and Eryayla cultivars had thicker lateral shoots and longer internodes than Marigoule. Ersinop cv. had fewer lenticel density on lateral shoot than the other cultivars.

Table 2: Tree, leaf, flower, bur and fruit characteristics of Ersinop and Eryayla chestnut cultivars comparatively with the Marigoule cv

Descriptor name	Ersinop	Eryayla	Marigoule
Tree and shoot characteristics			
Tree vigor	Vigorous	Vigorous	Vigorous
Growth habit	Semi-upright	Semi-upright	Semi-upright
Shoot density	Intermediate	High	Intermediate
Colour of shoot	Light brown	Brown	Reddish brown
Thickness of shoot (mm)	Thick (6.34)	Thick (6.13)	Thin (5.59)
Length of internodes (mm)	Long (37.6)	Long (37.1)	Short (29.6)
Lenticel density (no. per cm ²)	Sparse (20.5)	Intermediate (27.0)	Intermediate (29.0)
Phenological characteristics			
Time of leaf bud burst	Very early (29 Mar.-21 Apr.)	Early (3-22 April)	Early (2-20 April)
Begin. to bloom of male catkins	Interm. (1-8 June)	Very early (26 May-6 June)	Interm. (4-9 June)
Begin. to bloom of female catkins	Interm. (1-16 June)	Very early (26 May-15 June)	Interm. (3-17 June)
Ripening time	Very early (4-19 Sept.)	Very early (10-25 Sept.)	Interm. (29 Sept.-8 October)
Time of leaf fall	Early (21-29 November)	Early (21-28 November)	Late (2-10 December)
Leaf characteristics			
Shape of leaf tip	Attenuate acuminate	Acuminate	Aristate
Incisions of margin (habit of teeth)	Mucronate	Mucronate	Dentate
Leaf area, leaf size (cm ²)	Small (81.8)	Large (111.9)	Small (75.8)
Lamina width (cm)	Intermediate (5.43)	Large (6.65)	Intermediate (5.67)
Lamina length (cm)	Intermediate (21.2)	Long (23.5)	Short (18.9)
Leaf length (cm)	Intermediate (23.7)	Long (25.6)	Short (21.0)
Petiole length (mm)	Long (24.7)	Short (20.7)	Short (20.9)
Ratio of lamina width/lamina length	Intermediate (0.26)	Large (0.28)	Large (0.30)
Ratio of lamina width/leaf length	Intermediate (0.23)	Large (0.26)	Large (0.27)
Ratio of teeth width/teeth length	Large (0.50)	Large (0.54)	Large (0.46)
Flower characteristics			
Habit of male catkin	Spreading	Upright	Intermediate
Length of stamen filament (mm)	Longistaminate (6.39)	Longistaminate (7.27)	Longistaminate (5.77)
Length of male catkin (cm)	Long (22.6)	Short (10.3)	Long (20.4)
Length of mixed catkin (cm)	Long (15.7)	Short (5.9)	Long (12.8)

Table 2: Continued

Bur characteristics			
Shape of bur	Globular	Squarely globular	Squarely globular
Length of spine (mm)	Intermediate (16.3)	Intermediate (15.5)	Short (13.6)
Density of spine (number. per cm ²)	Low (120.4)	Intermediate (192.5)	Low (137.0)
Size of bur	Small (4364)	Small (3593)	Large (9454)
Fruit characteristics			
Fruit shape	Globose (100)	Broad ovoid (104)	Trans. broad ellips. (123)
Rel. size of hilum in relation to fruit	Small (0.49)	Small (0.56)	Large (0.84)
Brightness of pericarp	Very bright	Absent	Bright
Colour of pericarp	Blackish Brown	Dark Brown	Blackish Brown
Density of tomenta on fruit tip	Intermediate	Intermediate	Low
Chestnuts with a split pericarp (%)	Low (6.1)	Low (1.0)	Low (7.2)
Size of fruit	Very small (169 nuts/kg)	Very small (208 nuts/kg)	Big (61 nuts/kg)
Colour of kernel	Cream	Light cream	Cream
Peeling of seed coat in fresh fruit	Very easy	Very easy	Easy
Penetrat. of seed coat into the embr.	No penetration	No penetration	Weak penetration
Polyembryony (%)	Low (2.5)	Absent	Absent
Sweetness	Tasteful	Tasteful	Good
Hilum size	Small (178)	Small (176)	Large (693)
Shape of hilum	Elliptical medium (2.0)	Elliptical medium (2.1)	Elliptical broad (1.7)
Nut stripes	Absent	Absent	Absent



Fig. 1: Ersinop: leaves, male catkins and fruits

Bud burst was earlier 4-5 days in Ersinop. However Eryayla cv. started to bloom 6-10 days earlier than the other cultivars. Ersinop and Eryayla cultivars ripened 24 and 19 days earlier respectively than Marigoule. Leaf fall of them were 11 days earlier than Marigoule. Ersinop and Eryayla cultivars had mucronate teeth unlike Marigoule. Eryayla had bigger leaves which had longer and wider lamina (Table 2). Some ratios in relation to dimension of leaf have also importance for cultivar identification. Eryayla had also bigger ratios of lamina width/lamina length and lamina width/ leaf length like as Marigoule. Habit of male catkin was spreading in Ersinop, upright in Eryayla and intermediate in Marigoule. All of them had longistaminate stament filament. However Eryayla cv. had short male and mixed catkins.

Shape of bur was globular in Ersinop and squarely globular in the other cultivars. Lengths of spine of Ersinop and Eryayla cultivars were longer, but both of them had smaller burs than Marigoule. Fruit shape was

globose in Ersinop, broad ovoid in Eryayla and transverse broad ellipsoid in Marigoule. Relative size of hilum in relation to fruit was smaller in Erfelek and Eryayla cultivars than Marigoule. Ersinop had very bright fruits unlike Eryayla. Colour of pericarp was dark brown in Eryayla and blackish brown in the other cultivars (Fig. 1-3). Ersinop and Eryayla cultivars had tasteful fruits. Peeling of seed coat of them was easier than Marigoule. However, fruit size of them was smaller than Marigoule (respectively 5.9, 4.8 and 16.3 g).

Splitting of pericarp and polyembryony are important problems in chestnut. Splitting of pericarp was 6.1 % in Ersinop, 1.0 % in Eryayla and 7.2 % in Marigoule; however, all cultivars were in the same group for this characteristic. Polyembryony was low (2.5 %) in Ersinop while it was absent in other cultivars. Penetration of seed coat into the embryo was absent in Ersinop and Eryayla cultivars and lower (= 2 mm) in Marigoule. Nut stripes on pericarp were absent in all of the studied cultivars.



Fig. 2: Eryayla: leaves, male catkins and fruits



Fig. 3: Marigoule: leaves, male catkins and fruits

For six years after planting, cumulative yield of 3705, 4860 and 6702 g/tree were obtained from Ersinop, Eryayla and Marigoule cultivars [14]. Eryayla was more precocious than Ersinop and Marigoule and started bearing in third year while it was fifth year in the other cultivars. Its productivity as number of bur was higher than Marigoule, but Marigoule had higher yield because of its bigger nuts. Earliness is very important characteristic in chestnut. Nuts of Ersinop and Eryayla ripen in the second and third week of September, respectively. Earliness cultivars have higher price even if they have small fruit size.

The susceptibility to chestnut blight disease of Ersinop and Eryayla cultivars was medium [23]. However we have observed fewer deaths because of chestnut blight during the experiment years 1998-2010 in Ersinop than Eryayla. The productivity of Ersinop was changeable to climatic factors (Unpublished data). Thus, this cultivar can be advised to areas having relatively higher sunshine duration and air temperature in the vegetation periods in chestnut zones. Finally, Ersinop has been released because of being earlier and more resistance to chestnut blight. Eryayla has been also released because of having shorter unproductive period after planting and more stability in yield in different ecologies [14,15].

Eryayla blooms at earliest. For this cultivar, Ersinop, SE 21-9 and Marigoule can be suggested as pollenizer.

Ersinop, SE 21-9 and Marigoule bloom approximately at the same time in mid season. So, they can be suggested as pollenizer to each other [24].

CONCLUSIONS

In the current study, morphological and phenological characteristics of Ersinop and Eryayla cultivars of which variety registration was completed in 2009 by Turkey Variety Registration and Seed Certification Centre (TTSM) and standard cultivar Marigoule were compared. The results of this study show that Ersinop and Eryayla are earliness cultivars and they have easy peeling and tasteful kernels for important in fresh consumption. They can be advised for establishing new chestnut orchards.

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