

Selection of Chestnuts (*Castanea sativa* Mill.) Grown in Nazilli District, Turkey*

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Abstract: The Nazilli region of Aydın province in Turkey leads in terms of number of chestnut trees and quantity of chestnuts produced. This research was conducted to determine chestnut genotypes having high yield and superior fruit quality in the Nazilli region. Overall fruit quality, fruit size, precocity, and suitability for paste processing of chestnut genotypes were investigated. The observed characteristics of genotypes were ranked using certain criteria. Number of fruit samples collected from 2001 to 2003 are 80 (2001), 46 (2002), and 38 (2003). The collected data were evaluated using the weighted-rankit method, with total points determined for 38 genotypes during the 3-year study. The results showed that genotype N-3-4 had the highest average points, i.e. 2857, followed by the genotypes N-20-2, N-23-1, N-19-2, and N-2-5 with 2743, 2738, 2735, and 2734 points, respectively. The performance of the selected genotypes that showed the highest performance in this study will be determined within similar growing conditions in subsequent trials.

Key Words: Chestnut (*Castanea sativa* Mill.), selection, weighted-rankit method

Nazilli İlçesi Kestanelerinin (*Castanea sativa* Mill.) Seleksiyonu

Özet: Aydın ili, Nazilli ilçesi, Türkiye kestane üretimi ve ağaç varlığı bakımından ilk sırada yer almaktadır. Bu çalışma Nazilli ilçesinde, doğal kestane ağaç popülasyonları içerisinde üstün verimli ve kaliteli genotipleri saptamak amacıyla yapılmıştır. Kestane genotiplerinin genel kalite, irilik, erkencilik ve kestane hamuru yapımına uygunluk bakımından değerlendirildiği bu çalışmada, genotipler incelenen özellikler bakımından sıralanmışlardır. 2001-2003 yılları arasında yürütülen bu çalışmada, ilk yıl 80, ikinci yıl 46 ve üçüncü yıl da 38 adet meyve örneği alınmıştır. İncelenen özellikler belirli ölçülere göre puanlanmış ve elde edilen veriler tartılı derecelendirme (weighted-rankit) yöntemiyle değerlendirilmiştir. Seleksiyon çalışmasında, seçime esas olan tartılı derecelendirme yönteminde, üç yıl boyunca örnek alınan 38 adet tipin aldıkları toplam değer puanları değerlendirildiğinde; ortalama değer olarak en yüksek puanı alan N-3-4 numaralı genotip toplam 2857 puan ile birinci olmuştur. Bunu izleyen, N-20-2 numaralı tip 2743 puan; N-23-1, 2738; N-19-2, 2735 ve N-2-5, 2734 puan ile en yüksek değere ulaşan genotipler olmuşlardır. Bu çalışmada seçilen üstün özelliklere sahip kestane genotiplerinin aynı koşullarda gösterecekleri performansları, ileriki çalışmalarda belirlenecektir.

Anahtar Sözcükler: Kestane (*Castanea sativa* Mill.), seleksiyon, tartılı-derecelendirme yöntemi

Introduction

Chestnuts and many temperate fruit tree species have been grown in Anatolia since ancient times. Chestnuts abundantly exist in the East Black Sea subsection, the Marmara region, and the Antalya coastal area via the

West Anatolia subsection in Turkey (Soylu, 1984). The leading chestnut-growing countries in the world are China, Korea, Italy, and Turkey. Of the total chestnut production in the world (1,122,224 t), 71.74% (805,000 t) came from China, and Turkey was in fourth place with 48,000 t (4.27%) (FAO, 2004).

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The Aegean, Black Sea, and Marmara are the leading chestnut-growing regions of Turkey. There were approximately 2,330,000 chestnut trees in the country, consisting of 1,860,000 bearing trees and 470,000 non-bearing trees (DİE, 2003). Aydın province provided 27.93% of the total chestnut production in Turkey (DİE, 2003), followed by İzmir, Sinop, Kastamonu, Kütahya, Bartın, Balıkesir, Manisa, Zonguldak, and Bursa.

Since chestnut growing in Anatolia dates back to ancient times, numerous chestnut genotypes with different tree characteristics and fruit quality have emerged (Soylu and Ufuk, 1994). This is evident from the chestnuts sold in local markets. These chestnuts vary in terms of taste, color, shape, and peeling. In Anatolia, there was a great diversity among the 2,500,000 chestnut trees. Within these rich genetic sources, we can find genotypes having high yields, attractive and bright color, and large fruit size, and those having fewer, smaller and low-quality fruits (Soylu, 1984).

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 continue to select and vegetatively propagate the genotypes with high yielding potential. Breeders have recently studied selections from natural chestnut populations and obtained standard cultivars that are widely used.

The first chestnut studies in Turkey were conducted in the Marmara Region in 1975 (Ayfer et al., 1977). In addition, chestnut cultivar and rootstock selections studies were conducted in different countries (Liu, 1993; Pereira et al., 1993; Stampar et al., 1993; Solar et al., 1999). Cultivar selection studies carried out in the Aegean and Black Sea regions followed. With these studies, the fruit characteristics of local chestnut genotypes and cultivars belonging to the same region were determined (Ayfer et al., 1977; Ayfer et al., 1986; Ayfer and Soyly, 1993; Özkarakaş et al., 1995; Serdar, 1995; Akça and Yılmaz, 1999; Serdar, 1999; Serdar and Soyly, 1999). Even with these studies, information on local selection and spot selection (local selections made in certain areas in the vicinity) was insufficient. Spot-selection studies can permit more reliable results with an intensive effort within a limited area than those using well-known genotypes only.

This research aimed to determine high-yielding and good-quality chestnut genotypes within naturally grown chestnut populations located in Nazilli district, Aydın province. It was also conducted to initiate spot-selection studies on chestnut, which were lacking to a certain extent. In addition, this study may help to preserve the diminishing genetic resources and to obtain quality genotypes that reside in well-off natural populations.

Materials and Methods

Materials

This research was conducted in Nazilli district, Aydın province, between 2001 and 2003. Chestnut growing was carried in 30 villages in the Nazilli district. The genotype selection site is shown in Figure 1.

During the course of this study, 25 villages were evaluated in the selection program. Fruit samples were collected from 80 trees that were grown in these villages (from 71 growers). These fruit samples constituted the principal materials for the first year of the study. The samples taken in the first year were subjected to physical evaluation using a set of selection criteria. Based on the evaluation, the number of samples was reduced in the following years. The reduced numbers of fruit samples were collected in the second (46 trees) and third year (38 trees) of the study at harvest. As part of the selection study, fruit samples collected from the 38 trees were evaluated for 3 years. The goal was to determine the year-to-year performance of the 38 trees selected. Detailed information on the trees selected (including name of growers, location, and altitude) is presented in Table 1. A selection number was assigned to each sample tree.

Methods

Selection of research area and chestnut genotypes

Trees having large, imposing, and quality fruit, besides having high and regular yield, were selected for this research. From each tree possessing the identified characteristics, fruits were taken from 3-kg fruit samples with a burr. A selection number was assigned to each sample.

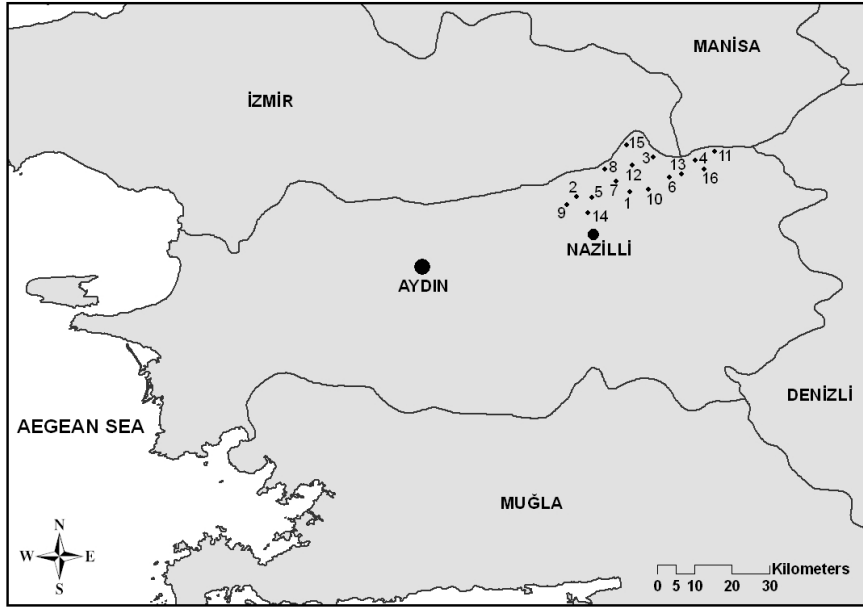


Figure 1. Map of the area where the selection study was conducted in Nazilli district, Aydın province.

(1: Ketendere, 2: Sinekçiler, 3: Karahallı, 4: Kahvederesi, 5: Kavacık, 6: Ovacık, 7: Çatak, 8: Apaklar, 9: Çobanlar, 10: Bekirler, 11: Aşağı Yakacık, 12: Işıklar, 13: Ketenova, 14: Hasköy, 15: Esentepe, 16: Kuşçular villages are shown).

Determination of pomological characteristics of fruit samples

The weighted-rankit method used in similar research (Ayfer and Çelik, 1977; Ayfer et al., 1977; Büyükyılmaz and Bulagay, 1985; Büyükyılmaz et al., 1988; Ayfer and Soylu, 1993; Özkarakaş et al., 1995; Serdar, 1995) as proposed by Michelson et al. (1958) was employed for the determination of the highest ranked genotypes within the fruit samples (Table 2). The evaluation of the chestnut genotypes included pomological characteristics. These characteristics were graded according to their distinctive attributes. The total points for each chestnut genotype were calculated by multiplying the points of quality class by a relative point of that type. The highest ranked genotype was determined with respect to the points calculated for each chestnut genotype as shown in Table 2. The grading system used by Ayfer et al. (1977) was also utilized in observing, counting, and measuring these characteristics.

Analysis was conducted with 3 replications, each of 20 fruits. The results from the 3-year average of general quality, size, precocity, and suitability for chestnut paste results and total weighted-rankit scores were determined for the chestnut genotypes.

Weighted-determination of the important pomological characteristics of genotypes

The pomological characteristics of chestnut genotypes are important for growers and consumers and as equally crucial as general quality evaluation. To give weighted-rankit emphasis on large fruit size, precocity, and suitability for chestnut paste besides general quality evaluation with the selection of highly ranked quality genotypes, separate relative scores were calculated for each characteristic evaluated. Thus, selection of genotypes with the largest fruit, the most precocious, and the most suitable for chestnut paste becomes easier (Ayfer et al., 1977; Ayfer et al., 1986; Soylu and Ufuk, 1994; Serdar, 1995).

The selected genotypes were evaluated considering their total weighted-rankit scores and total relative points for each characteristic.

Results and Discussion

The results from the 3-year average of general quality, size, precocity, and suitability for chestnut paste results and total weighted-rankit scores determined for 38 chestnut genotypes during 2001-2003 are presented in Table 3.

Table 1. Information about the trees used in the selection study in 2001-2003.

Selection number	Growers	Villages	Altitude (m)
N-2-3	Hakkı GÜNGÖR	Ketendere	1170
N-2-5	Tahir ÇAM	Ketendere	1100
N-3-2	Aydın ALTISU	Sinekçiler	1120
N-3-4	Ali BAŞOĞLU	Sinekçiler	1150
N-3-5	Ali BAŞOĞLU	Sinekçiler	1150
N-4-1	Hüseyin TOPALOĞLU	Karahallı	1180
N-4-2	Hasan KAVLAĞOĞLU	Karahallı	1180
N-4-3	Hasan GÜLER	Karahallı	1200
N-4-4	Şükrü KULAKOĞLU	Karahallı	1200
N-4-5	Yaşar ÖZDEMİR	Karahallı	1200
N-4-6	Mehmet TOPÇUOĞLU	Karahallı	1180
N-5-1	Erdoğan KARAKUŞ	Kahvederesi	700
N-7-3	Hasan UĞUR	Kavacık	1210
N-7-4	Hasan UĞUR	Kavacık	1210
N-8-2	Mehmet EFE	Ovacık	900
N-8-3	Mehmet ARKAYIN	Ovacık	915
N-8-4	Fadime TOPAN	Ovacık	825
N-14-1	Mustafa AVCI	Çatak	1180
N-14-2	İsmail ERİŞ	Çatak	1200
N-15-2	İsmail BİLİCİ	Apaklar	1220
N-16-4	İsmail KÖSE	Çobanlar	1000
N-17-1	Necati AYDIN	Bekirler	850
N-17-2	Osman BAŞPINAR	Bekirler	880
N-18-1	Mehmet ÇAKIR	Aşağı Yakacık	680
N-19-1	Nurettin KÖŞKÜOĞLU	Işıklar	800
N-19-2	İbrahim KARAMAN	Işıklar	900
N-19-3	Hayrullah KARABULUT	Işıklar	900
N-19-4	Hüseyin KARAMAN	Işıklar	1000
N-20-1	Ali KIRMIZI	Ketenova	915
N-20-2	Ali KIRMIZI	Ketenova	915
N-21-1	Mehmet AKTAN	Hasköy	1200
N-21-2	İrfan KARLIDAĞ	Hasköy	1315
N-21-3	Muzaffer BULGUR	Hasköy	1300
N-22-1	Mehmet ÇAKIR	Esentepe	915
N-22-2	Ali ACAR	Esentepe	920
N-23-1	Mehmet KÖMÜRCÜOĞLU	Kuşçular	1060
N-23-3	Hüseyin BÖKE	Kuşçular	1100
N-23-4	Mustafa KÖMÜRCÜOĞLU	Kuşçular	1085

Table 2. Relative scores for pomological parameters in chestnut selection according to general quality, size, precocity, and suitability for chestnut paste (Ayfer et al., 1977).

Characteristics	Relative scores				Class of the characteristics and their scores
	General quality	Nut size	Precocity	Chestnut paste	
1. Fruit bearing	15	15	15	15	Very Good: 10, Good: 7, Medium: 4, Low: 1
2. Number of nuts per burr	10	10	10	10	3.0-2.5: 10, 2.4-1.5: 6, 1.4-1.0: 3
3. a) Shell color	10	10	5	0	Typical Chestnut Brown: 10, Slightly Dark: 7, Light Brown: 4, Dark: 1
b) Shell brightness	5	5	5	0	Bright: 10, Matt: 4, Hairy: 1
c) Shell thickness	3	3	3	3	Very Thin (≤ 0.42 mm): 7, Thin (0.43-0.48 mm): 5, Slightly Thick (0.49-0.60 mm): 3, Thick (≥ 0.61 mm): 1
d) Shell hardness	2	2	2	2	Soft: 3, Slightly Hard: 2, Hard: 1
4. Nut size (number of nuts per kilogram)	15	30	15	10	Very Large (≤ 55): 10, Large (56-65): 8, Medium (66-85): 6, Small (86-100): 3, Very Small (≥ 100): 1
5. Kernel color	10	10	5	15	Light Cream: 10, Cream: 5, Dark Cream: 1
6. Testa Peeling	10	8	5	20	Peel Easily: 10, Peel Fairly Easily: 5, Peel with Difficulty: 1
7. Testa Entering the Seed (mm)	0	0	0	10	Did Not Enter or Slightly Entered (≤ 1.0 mm): 10, Entered Somewhat (2.0-3.0 mm): 7, Deeply Entered (≥ 4 mm): 1
8. Precocity	10	0	30	0	Very Early: 10, Early: 7, Mid season: 5, Late: 3, Very Late: 1
9. Taste	10	7	5	15	Delicious: 10, Good: 7, Medium: 4, Poor: 1
TOTAL	100	100	100	100	

Genotype N-3-4 had the highest general quality score (725). The other high scorers were determined in genotypes N-20-2 (703), N-19-2 (699), N-2-5 (698), and N-7-3 (694) (Table 3). On the other hand, the genotypes with low quality scores were N-17-2 (526), N-21-3 (545), and N-19-3 (551).

In terms of fruit size, genotypes N-3-4 (731), N-7-3 (726), N-23-1 (714), N-5-1 (713), and N-20-2 (698) had high scores, whereas genotypes N-17-2 (473), N-21-3 (518), and N-23-3 (529) had low scores as per the weighted-rankit method.

In terms of precocity, genotypes N-3-4 (774), N-20-2 (734), N-3-2 (722), N-3-5 (710), and N-23-1 (705) had high scores. The genotypes with low precocity scores were N-21-3 (570), N-17-2 (591), and N-19-3 (609).

Considering suitability for chestnut paste, genotype N-2-5 (688) had the highest score, followed by genotypes N-19-1 (661), N-8-2 (648), N-2-3 (648), and N-4-5 (647). Genotypes N-20-1, N-17-2, and N-16-4 had relatively low scores in this regard.

When the total value scores determined using the weighted-rankit method for each chestnut genotype were evaluated, genotype N-3-4 had the highest score (2857) (3-year average), followed by genotypes N-20-2 (2743), N-23-1 (2738), N-19-2 (2735), and N-2-5 (2734) (Table 3).

Based on the evaluation results, the 6 genotypes having the highest rank were selected using at least 2 characteristics and total scores considering the evaluated characteristics (general quality, size, precocity, suitability

Table 3. Total value scores and average scores of general quality, size, precocity and suitability for chestnut paste of the chestnut genotypes in the selection study during 2001, 2002 and 2003.

Selection number	General quality	Nut size	Precocity	Chestnut paste	TOTAL SCORES
N-2-3	684 (10)	644	701 (7)	648 (4)	2677 (8)
N-2-5	698 (4)	653	695	688 (1)	2734 (5)
N-3-2	690 (7)	647	722 (3)	615	2675 (9)
N-3-4	725 (1)	731 (1)	774 (1)	627 (8)	2857 (1)
N-3-5	647	679 (8)	710 (4)	512	2548
N-4-1	625	651	645	564	2485
N-4-2	603	582	638	510	2333
N-4-3	684 (9)	686 (7)	701 (6)	596	2667
N-4-4	665	651	680	573	2568
N-4-5	692 (6)	654	684	647 (5)	2677 (7)
N-4-6	652	615	667	612	2546
N-5-1	678	713 (4)	673	607	2672 (10)
N-7-3	694 (5)	726 (2)	696 (9)	617 (10)	2733 (6)
N-7-4	641	627	646	617 (9)	2531
N-8-2	675	634	698 (8)	648 (3)	2655
N-8-3	573	561	638	538	2310
N-8-4	577	544	637	474	2233
N-14-1	650	630	655	578	2512
N-14-2	656	668 (9)	666	581	2570
N-15-2	601	598	627	579	2405
N-16-4	563	548	635	455	2202
N-17-1	627	585	667	525	2403
N-17-2	526	473	591	439	2029
N-18-1	577	602	620	464	2263
N-19-1	674	656	674	661 (2)	2666
N-19-2	699 (3)	694 (6)	695 (10)	647 (6)	2735 (4)
N-19-3	551	533	609	501	2195
N-19-4	573	552	618	516	2258
N-20-1	558	591	658	432	2240
N-20-2	703 (2)	698 (5)	734 (2)	608	2743 (2)
N-21-1	599	572	621	578	2370
N-21-2	602	588	614	522	2326
N-21-3	545	518	570	507	2140
N-22-1	640	658	678	485	2461
N-22-2	640	631	667	532	2470
N-23-1	689 (8)	714 (3)	705 (5)	630 (7)	2738 (3)
N-23-3	582	529	617	577	2304
N-23-4	644	667 (10)	678	571	2560

Numbers in parentheses indicate ranking of scores of the genotypes

for chestnut paste, and total score). When Table 3 was analyzed, genotypes N-3-4, N-20-2, N-23-1, N-19-2, N-2-5, and N-7-3 having the best characteristics were selected as promising genotypes. Consequently, these 6 genotypes were selected considering all data from weighted-rankit method during the 3 years. Some characteristics of the selected chestnut genotypes are given in Table 4.

Fruit size was the main criterion considered in the study of chestnut genotype evaluation and selection. The average fruit weights were determined between 13.45 and 19.69 g for the selected genotypes. Based on these fruit weights, the number of fruits per kilogram varied between 51 and 74. These values demonstrated that the selected genotypes in this study were superior in terms of fruit size to those that exist in other regions or provinces. For example, Ayfer and Soylu (1993) conducted a chestnut genotype selection study in the Marmara region and reported that the average chestnut fruit weight varied between 5.00 and 21.40 g. Similarly, in the chestnut genotype selection study performed in Erfelek district (Serdar, 1995), fruit weight was reported between 5.46 and 10.78 g during 3 years. It is clear

from our findings that chestnut fruits in the Nazilli region weighed almost 2-fold more than the fruits in the Marmara region. On the other hand, fruits in the Nazilli region resembled fruits in the Aegean region in term of size according to the genotype selection study carried out by Özkarakas et al. (1995), reporting fruit weights between 8.85 and 18.51 g.

In chestnut selection studies, yield is the most important selection criterion. The chestnut yield per tree depends on the number of burrs, the number of fruits per burr, and size of fruit. In general, when the fruit number increases in the burr, the fruit size decreases. Genotype N-3-4 had 2.80 fruit per burr and average 19.39 g fruit weight, a 'violation' of the rule. Since it is an important characteristic for the genotypes, it explains why genotype N-3-4 yielded the highest score in the weighted-rankit method.

All the chestnut genotypes evaluated in the present study had bright and brown shell color of fruit as in general. However, it may change from pale to light brown. When fruit skin thicknesses of the chestnut genotypes were evaluated, they were found to have thick skins. The skin thickness scores varied between 0.39 and

Table 4. Some characteristics of the selected chestnut genotypes.

Genotype	Number of nuts per burr	Average nut weight (g)	Nut shell thickness (mm)	Nut width (mm)	Nut length (mm)	Nut height (mm)	Kernel ratio (%)*	Entering seed (mm)
N-2-5	2.28 (0.118)	13.45 (0.667)	0.39 (0.014)	18.95 (0.234)	35.17 (1.186)	30.39 (0.583)	0.79 (1.190)	5.98 (4.472)
N-3-4	2.80 (0.072)	19.39 (0.915)	0.46 (0.044)	22.02 (0.985)	40.90 (0.883)	33.28 (0.093)	0.79 (2.163)	11.07 (6.153)
N-7-3	1.82 (0.102)	19.69 (0.242)	0.52 (0.014)	23.70 (1.476)	41.18 (0.745)	34.28 (0.281)	0.82 (1.247)	8.04 (3.340)
N-19-2	1.55 (0.106)	16.88 (0.605)	0.47 (0.039)	21.90 (0.643)	38.54 (1.305)	33.08 (1.506)	0.82 (0.286)	7.30 (4.974)
N-20-2	1.92 (0.069)	16.93 (1.228)	0.58 (0.031)	22.33 (1.433)	37.65 (0.176)	32.68 (0.441)	0.82 (0.176)	4.80 (1.621)
N-23-1	1.82 (0.190)	18.83 (0.565)	0.44 (0.029)	22.41 (0.188)	38.66 (0.557)	34.31 (0.435)	0.83 (0.835)	3.94 (1.457)

The numbers in the parentheses are standard deviations

* KR values (%) transformed into arc-sinus.

0.58 mm (Table 4). When these results were compared with the previous studies, the Nazilli region fruits resemble those of the Marmara, Black Sea and Aegean regions (Ayfer et al., 1977; Ayfer and Soylu, 1993; Özkarakaş et al., 1995; Serdar, 1995).

The peeling off the testa and entrance of the testa into the flesh ought to be the main criterion used for selecting chestnuts. This characteristic varied among the genotypes. When the general characteristics observed in this study were considered, it was determined that generally the testa entered a little into the kernel and the testa peeled off easily. In a selection study performed in the Marmara region, differences were observed among the genotypes in terms of peeling off of the testa (Ayfer et al., 1977; Ayfer and Soylu, 1993). The testa also entered the flesh in different ratios.

When fruit dimensions of the selected chestnut genotypes were investigated, average nut width, length, and height were 18.95-23.70 mm, 35.17-41.18 mm, and 30.39-34.31 mm, respectively. When the results of selection studies in the Marmara (Ayfer et al., 1977) and Black Sea (Serdar, 1995) regions were considered, the dimensions of the chestnuts grown in Nazilli were similar to those found in the Marmara region. The fruit

dimensions were smaller in chestnuts grown in the Black Sea region. The flesh/fruit ratio was observed to vary between 67.64% and 88.62%, which was different from the genotypes investigated in the Black Sea region.

Conclusions

This study is significant because it is the first selection work in Nazilli district. To make an objective comparison of fruit quality, precocity, and yield of these selected genotypes, they all need to be grown using the same rootstock, soil, climate, and cultural practices. Adaptation studies will also be required for the selected chestnut genotypes. Therefore, chestnut genotypes selected in the first stage of selection should be studied in the second stage of selection.

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