the long and short axes ~45 and 40 mm respectively. Comparable diploid 'Meiwa' weigh ~14.6 g with average diameters for the long and short axes ~40 and 36 mm respectively (Fig. 3). Seeds of the tetraploid have the general appearance of being broader and larger than diploid seeds. Seeds of the tetraploid are ~11 mm long by 6.5 mm wide and vary in number, 0-5, per fruit. Seeds of the diploid are ~10 mm long by 5.5 mm wide and vary 0-6 per fruit. Juice samples of tetraploid 'Meiwa' gave values ~14.0% total soluble solids and titratable acidity ~5.44%. Comparable juice samples of diploid 'Meiwa' gave values of ~12.6% total soluble solids and titratable acidity ~4.85%. Container-grown tetraploid plants of 'Meiwa' are attractive ornamentals that produce larger fruit than ordinary, diploid 'Meiwa.' The morphological changes in the phenotype that occurred when the diploid *Fortunella* 'Meiwa' was converted to the tetraploid condition were analogous to the corresponding changes that occurred when diploid *Citrus* cultivars were converted to the tetraploid condition.

Literature Cited

1. Barrett, H. C. 1974. Colchine-induced polyploidy in *Citrus*. Bot. Gaz. 135(1):29-41.

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A Selection Study on Determining Important Characteristics of Almond Trees in Turkey

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Abstract

In this study, carried out in 1988, 450 almond trees (*Amygdalus communis* L.) were examined to select the important quality fruit types in natural almond population grown around the Apa Dam Lake in Cumra, Konya, Turkey, and of them 12 types were selected with regard to fruit characteristics. All selected types were seen to have the characteristics of late flowering. The average inshell fruit weights were between 3.37 g and 5.24 g. The kernel weights were 0.64 and 1.00 g and the ration kernel were 14.29% and 20.01%. All types had extremely hard shell almond characteristics.

Introduction

The homeland of the almond tree (*Amygdalus communis* L.) is the lower mountainous region of Middle Asia. Almond is an inshell fruit which is grown commercially in an area extending from Afghanistan and Iran to Southeast Asian of India and more plato countries and more particularly in Mediterranean countries, Middle East and California (9). Archeological excavations carried out in Southeast Anatolia, Turkey, discovered almond seeds from 7000 B.C. (14).

Almond trees growing in a vast region with different ecological conditions have formed a number of populations, variations and local types due to the influence of agricultural techniques of related countries. In addition to natural selection, some countries like Iran, Uzbekistan and Afghanistan have made conscious selection by farmers, thus, some almond types lasting cold hardness were found. On the other hand, some types expressing low chilling requirement for bloom have appeared on the coast of the Mediterranean region (11). Although development in almond production is very slow in its homeland region, very rapid

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development has occurred in certain countries like the United States. This can be explained in two ways: Due to having early blooming of almond, non stable production, or the social and economical structure of these countries has favored development (8).

Bringing almond cultivars from countries such as United States, where these cultivars are standardized and considerable improvement has been achieved, is a means of increasing the rate of development (5). Nevertheless, improvement of almond production in these countries, requires utilization of the rich genetic materials suitable for environmental conditions in various regions of Asia and Europe where almond seedlings have been used in production. Grasselly (10) states that it is essential for genetic improvement strategies combine available materials from Mediterranean countries. However, it is not certain under which conditions the imported materials will give satisfying results. Therefore, to start growing with limited cultivars might give rise to difficulties in solving production problems (11). Yet valuable imported cultivars should also be included in studies of germplasm selection.

In Anatolia, growing seedlings is the usual procedure wherever production from clonally propagated trees is rare. Since fruits and seeds are a result of cross pollination and seedlings are highly heterozygous, all seedlings obtained are different from each other. Hence, the almonds grown in Turkey are highly variable in tree and fruiting characteristics. In order to standardize almond production, the first step, was to select individuals from available large populations in West Anatolia beginning in 1966, and place in a collection gardens in Bomova, Izmir (6).

The major areas of Turkish almond production are the Aegean, Mediterranean, Central Anatolia and Marmara Regions. Turkey ranks sixth in the world in domestic almond production, but has had insignificant almond exports. However, in recent years, there has been an increase in almond exports. It is estimated that some 4,815,000 almond trees are grown in Turkey of which 4,054,000 bear (2).

This study was carried out to select suitable types for standardization and high quality among the almond population grown around Apa Dam Lake, Cumra, Konya.

Material and Method

Material

This research was conducted on almond trees in the Selcuk University Research and Application Farm, and on trees grown around Apa Dam Lake

Table 1. Tree features in selected almond types.

Apa Selection	Shape of Tree	First Blooming Time (1989)	Different Length of Diameter Trunk (cm)	Length of Annual Shoots (cm)
A-11	Spreading	5 April	16±1.140	10±0.707
A-37	Upright-Spread	4 April	10±1.140	25±0.707
A-53	Upright-Spread	3 April	3±0.273	10±1.964
A-81	Upright-Spread	6 April	7±0.707	15±0.860
A-134	Very Spread	5 April	8±0.707	20±0.860
A-192	Spreading	4 April	10±1.048	15±1.593
A-195	Upright-Spread	6 April	20±1.469	10±1.303
A-240	Upright-Spread	31 March	8±0.447	10±0.244
A-274	Upright	2 April	7±0.447	23±3.066
A-302	Very Upright	1 April	15±0.707	30±1.400
A-339	Very Upright	4 April	12±0.707	20±2.200
A-400	Upright	5 April	13±0.707	25±1.048

Table 2. Characteristics of inshell fruit in selected almond types.

Apa Selection	Inshell fruit weight (g)	Shell weight (g)	Shell Fruit Length (cm)	Width (cm)	Thickness (cm)	Width* index (W/L, %)	Thickness** index (T/L, %)	Shell thickness (mm)	Nut shell breaking index[z]	Size[y]	Nut surface roughness[x]	Color[w]
A-11	4.27±0.190	3.34±0.170	3.14±0.030	2.10±0.030	1.34±0.010	66.87±1.112	42.67±0.552	0.4±0.031	4	4	1	2
A-37	4.77±0.482	3.89±0.067	3.42±0.094	2.05±0.016	1.55±0.034	59.95±2.176	42.32±2.822	0.4±0.031	4	4	1	2
A-53	3.37±0.294	2.70±0.096	2.97±0.036	1.82±0.020	1.20±0.014	61.27±1.897	40.40±0.795	0.3±0.001	4	3	2	4
A-81	3.82±0.054	3.08±0.054	2.64±0.052	1.82±0.032	1.32±0.024	68.93±1.895	50.50±0.760	0.3±0.012	4	3	2	4
A-134	3.74±0.248	2.95±0.031	2.73±0.029	1.93±0.021	1.44±0.026	70.69±1.944	52.74±0.824	0.3±0.022	4	3	2	3
A-192	4.23±0.440	3.33±0.029	3.37±0.057	1.98±0.038	1.40±0.047	58.75±1.007	41.54±1.146	0.3±0.015	4	4	1	4
A-195	4.19±0.158	3.14±0.049	3.62±0.071	2.55±0.047	1.74±0.040	70.44±1.155	48.06±1.031	0.3±0.001	4	4	4	4
A-240	4.07±0.033	3.27±0.017	3.40±0.313	1.82±0.029	1.35±0.016	53.52±0.802	39.70±0.542	0.3±0.022	4	3	2	4
A-274	3.92±0.041	3.20±0.017	3.88±0.085	1.90±0.033	1.27±0.026	48.96±0.802	37.57±0.765	0.3±0.004	4	4	1	4
A-302	5.24±0.390	4.28±0.006	3.39±0.087	2.22±0.038	1.57±0.036	65.48±0.827	46.31±1.807	0.4±0.007	4	4	2	4
A-339	5.05±0.035	4.25±0.009	3.05±0.091	2.11±0.214	1.56±0.010	69.18±1.680	51.14±2.090	0.4±0.002	4	4	1	1
A-400	3.94±0.095	3.04±0.008	2.70±0.030	2.70±0.030	1.39±0.027	90.30±1.821	46.48±1.173	0.4±0.003	4	3	4	3

*Width index: Width/length x 100.
**Thickness index: Thickness/length x 100.
[z]Nut shell breaking index: 1. Hand almond, 2. Teeth almond, 3. Hard almond, 4. Stone almond.
[y]Size: 1-5, very small to very large.
[x]Nut surface roughness: 1. Slippery, 2. Little roughness, 3. Middle roughness, 4. Fuzzy, 5. Very fuzzy.
[w]Nut shell color: 1. Beige color, 2. Dark beige, 3. Milky coffee, 4. Pale coffee (Flesh coloured).

in the vicinity of Cumra town, Konya. The research area is ca. 65-70 km south of Konya city center and 30-35 m high from Konya plateau. This plateau is generally flat with an arid climate. The annual rainfall is 280 mm. The highest temperature recorded was 37.4 °C and the lowest was -26.8 °C. The average relative humidity is 66%. The average frost period in the region is from the 22 October to the 14 April (1). The soil in the research area is low in organic matter and is not economical in terms of agriculture. There are problems concerning salinity and alkalinity (3).

This research was conducted on almond trees grown around Apa Dam Lake in 1988. This is the first step in selection studies to improve almond production in Konya region. Almond trees in the research area were grown from seeds. In the research and surrounding area, almond trees are grown for several purposes such as border trees, shady spots in gardens and for plantation. No growing for nut production, was recorded. Agricultural practices like pruning, fertilization, spraying, protecting, irrigation and tillage are not performed.

Method

The 12 types were selected for the best inshell types and stone quality. The pomological analyses were done on shelled nuts and kernels according to Gülcan (12).

Table 3. Characteristics of kernel in selected almond types.

Apa Selection	Kernel weight (g)	Kernel ratio (%)	Kernel Nut Length (cm)	Width (cm)	Thickness (cm)	Width* index (W/L, %)	Thickness** index (T/L, %)	Double kernel rate (%)	Number per ounce	Smooth[z]	Fuzzy[y]	Fullness[x]	Separation from shell[w]	Color[v]
A-11	0.85±0.032	18.00±0.158	2.16±0.024	1.18±0.020	0.52±0.020	54.63±1.433	24.07±0.837	--	33	1	2	4	4	2
A-37	0.82±0.007	17.35±0.140	2.30±0.037	1.06±0.048	0.60±0.024	46.08±2.045	26.08±2.045	30.0	34	2	2	4	4	3
A-53	0.64±0.034	17.18±0.202	2.18±0.048	1.12±0.020	0.58±0.037	51.37±2.111	26.60±2.011	--	44	2	2	3	4	3
A-81	0.72±0.049	17.00±0.163	2.32±0.037	1.06±0.024	0.68±0.080	45.69±1.004	29.31±0.860	--	39	2	2	3	4	3
A-134	0.75±0.017	20.01±0.544	2.02±0.020	1.20±0.020	0.70±0.026	59.40±0.571	34.65±0.334	20.0	37	2	2	4	4	3
A-192	0.87±0.023	16.53±0.701	2.30±0.456	1.24±0.040	0.62±0.020	53.91±2.269	26.95±1.265	20.0	32	4	2	3	4	3
A-195	1.00±0.027	14.29±0.464	2.44±0.040	1.46±0.112	0.60±0.044	59.83±3.967	24.59±0.414	--	28	3	2	3	4	3
A-240	0.75±0.035	18.42±0.854	2.54±0.037	1.04±0.024	0.60±0.040	40.95±0.456	23.62±0.471	20.0	37	5	3	4	4	5
A-274	0.67±0.023	15.52±0.580	2.78±0.020	1.14±0.024	0.54±0.024	41.00±0.480	19.42±0.583	10.0	41	4	3	4	4	4
A-302	0.86±0.018	16.40±0.218	2.50±0.112	1.40±0.031	0.62±0.024	56.00±0.671	24.80±1.186	--	32	2	3	3	4	4
A-339	0.73±0.042	17.70±0.353	2.18±0.020	1.18±0.020	0.64±0.024	54.12±1.399	24.35±1.318	--	28	3	2	4	4	4
A-400	0.87±0.027	20.04±0.499	2.22±0.037	1.22±0.020	0.72±0.024	54.95±1.369	32.43±1.104	--	32	3	3	4	4	3

*Width index: Width/length x 100.
**Thickness index: Thickness/length x 100.
[z]Smooth: 1-5, rough to very smooth.
[y]Fuzzy: 1-5, not fuzzy to very fuzzy.
[x]Fullness: 1-5, not full to very full.
[w]Separation from shell: 1-5, difficult to very easy to separate.
[v]Color: 1-5, very pale to very dark.

Of the original 450 almond trees evaluated, 110 were selected because of their sweet taste. Further selections based on 110 almond trees, resulted in the selection of 12 types.

Field studies began in the 1988 harvest season. Nut samples were collected from 450 almond trees bearing only good fruits that were determined using the observation technique. In the same year, the growing characteristics of the tree, the diameter of trunks, the length and width of tree shape, and the length of shoots, were measured from 12 trees. Cold damage and disease was observed (15).

Ten fruits were chosen from each almond tree. A 0.05 mm sensitive needled compass for dimension measurements, Herald Küppers "Farbenatlas" for color identification, a 0.01 g sensitive "Bosch PE 656" labelled balance for weight, and Biological Material Testing Instrument (developed by the Department of Agricultural Mechanization, Faculty of Agriculture, Selcuk University) for resistance of shell break were used (15, 13, 4).

The fruits belonging to 450 almond trees brought to the laboratory from the field were taste of which 110 were sweet while 340 types were bitter. The 110 trees with sweet fruits were used to determine kernel and shell characteristics. Data obtained from the fruit characteristics were evaluated by statistical analysis (6, 15, 7).

Results and Discussion

With regard to growing characteristics, two types of these were upright to spreading, five types spreading, two types upright and three types very upright (Table 1). All trees were found to be late-flowering, compared to Mediterranean types. The difference between the times of flowering among types were at most six days. The earliest flowering was seen in Apa-240 type and the latest flowering in Apa-81 and Apa-195.

Cold winter temperatures were caused by damaging 30-40% of the 12 selections in 1989 and 1990.

Other characteristics such as trunk diameter and shoot length are given in Table 1.

In 10 out of 12, inshell weights ranged from 3.4 g and 5.2 g, 10.0 g and percent of kernel was 14% and 20% (Tables 2, 3).

The selected types were examined with regard to nut surface roughness. Of them, one was smooth, and the rest were either roughness or half-roughness and half smooth. The fruits were less fuzzy or moderately fuzzy. The color varied from pale brown to dark brown. Separation from shell was good in 12 types. In terms of kernel size, one type was moderate and the rest were small (Table 3).

Average inshell almond weigh from 3.37 to 5.05 g, average kernel weighs from 0.64 g to 1.00 g, and the rate of double-kernel from 10% to 30% varied (Table 3).

The selected seedlings were similar to native selections and foreign standard types.

The history of almond production in Turkey is older than in other countries, however, these countries, have reached the last level in almond improvement. In Turkey, the improvement and production of almond trees have remained far behind the desired level. Therefore, selection studies of natural germplasm adapted to Turkey's growing conditions should continue as rapidly as possible.

This study is important in that it is the first almond selection program conducted from germplasm obtained for the Konya province of Central Anatolia and is a continuation of selection studies made before in Aegean and Mediterranean regions of Turkey. In this study, almond types adapted to climate and soil conditions of the region have been selected. Production of high quality almond production will contribute to the country's economy considerably; therefore, the standardization of almond production with selected desirable genotypes is essential, a goal which will be achievable as selection studies continue.

Literature Cited

1. Anonymous. 1980. Meteoroloji Bülteni. DMI Genel Müd. Yay. No : 459, Ankara.
2. Anonymous. 1987. Tarimsal Yapi ve Üretim. DIE Yay. No : 1376, Ankara.
3. Anonymous. 1971. Türkiye'deki barajlar ve hidroelektrik santrallari. D.S.I. Yay. No : Konya.
4. Aydin, C. 1989. Amasya elma cesidinin tarim teknigi yönünden önemli fiziko-mekanik özelliklerinin belirlenmesi. S.Ü. Fen Bilimleri Enst. (Yüksek Lisans Tezi), Konya.
5. Dokuzoguz, M. and R. Gülcan, 1973. Ege bölgesi bademlerinin seleksiyon yoluyla islahi ve secilmis tiplerin adaptasyonu üzerine arastirmalar. TÜBITAK Yay. No : 22, Ankara.
6. Dokuzoguz, M., R. Gülcan and A. Atilla. 1968. Ege bölgesi bademierinin seleksiyon yoluyla islahi üzerine arastirmalar. Ege Üniv. Ziraat Fak. Yay. No: 148, Izmir.
7. Düzgünes, O. ve Kesici, T. 1983. Istatistik Metodlari. Ankara Üniv. Ziraat Fak. Yay. No : 861, Ankara.
8. Evreinof, V. A. 1952. Quelqoe observations biologiques sur l'amandier. Rev. Int. Bot. Appl. Agric. Top. 32 : 422-459.
9. Grasselly, C. 1967. Selection de l'amandier en Azerbardjan Department d' Horticulture de la Faculte d' Agronomie de Tebriz, Iran.
10. Grasselly. C. 1971. L'arnandier et ses possibilities d'amelioration. Agronomia Lusit. 32 : 163-171.
11. Gülcan, R. 1976. Secilmis badem tipleri üzerinde fizyolojik ve morfolojik arastirmalar. Ege Üniv. Ziraat Fak. Yay. No : 310, Izmir.

12. Gülcan, R., 1985. Almond discriptons. Internation Board for Plant Genetic Resources Secretariad. Rome, 30 p.
13. Kuppers, H. 1987. Der Grobe Küppers-Farbenatlas. Verlag Georg D. W., Gollwey GmbH, Münnchen.
14. Sykes, I. T. 1975. Influence of climate on the regional distribution of nut crops in Turkey. Econ. Bot. 29:108-115.
15. Sen, S. M. 1986. Ceviz Yetistiriciligi. Ondokuzmayis Üniv. Ziraat Fak., Samsun.

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Performance of Ten Vigorous and Semi-Vigorous Apple Rootstocks Over Ten Years in British Columbia

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Abstract

A trial of 'Macspur McIntosh' on four seedling rootstocks (open-pollinated Antonovka, open-pollinated Haralson, Antonovka x Beautiful Arcade, Haralson x Beautiful Arcade) and six clonal rootstocks (B.118, I.48-41, M.2, M.4, M.7 and MO.56-4) was planted in 1986 to identify cold-hardy, yield-efficient apple rootstocks adapted to southern British Columbia. Spread and trunk cross-sectional area (TCA) were greatest for trees on MO.56-4 and smallest for trees on M.7. The height, spread and TCA of trees on the open-pollinated seedling rootstocks did not differ significantly, but TCA for trees on Haralson x Beautiful Arcade and Antonovka x Beautiful Arcade were smaller than on the open-pollinated seedling rootstocks. Trees on M.7 were the most precocious. Cumulative yield was high on MO.56-4, but its cumulative yield efficiency (cumulative yield/final trunk cross-sectional area) was among the lowest. Cumulative yield efficiency and canopy efficiency (cumulative yield/canopy volume over the last five years) were highest on M.7, M.4, and I.48-41. B.118 was similar to M.4 in height, spread, and TCA, but slightly lower in cumulative yield efficiency. All the seedling rootstocks were less precocious than M.7, and lower in cumulative yield efficiency than M.7 or M.4, but not M.2. Fruits from trees on Haralson x Beautiful Arcade and Antonovka x Beautiful Arcade were among the smallest. Rootstock did not affect the incidence of windfalls or the degree of bienniality of the scion. I.48-41, M.7 and open pollinated Haralson produced the most root suckers. Although yield performance was good on M.7, one of the trees died and another was seriously injured by a winter freeze during the study. Overall, M.4, B.118 and I.48-41 appear to have the greatest potential for cold sites.

Antonovka seedling rootstocks were planted commonly in southern British Columbia (B.C.) until the late 1980s because of their cold hardiness and resistance to crown rot. Haralson seedling rootstocks were also planted in B.C. during this period. A trial of standard to semi-vigorous rootstocks was initiated in 1986 to identify cold hardy, more yield-efficient, semi-vigorous rootstocks adapted to the region. Both seedling and clonal rootstocks were included in the trial.

Six clonal rootstocks were tested. Budagovsky 118 (B.118), from the Michurin College of Horticulture, Russia, was reported to be a cold-hardy rootstock resistant to crown rot and about equal to MM.106 in size-controlling ability (3, 4, 6). Pieniazek (8) noted that B.118 was precocious and more cold-hardy than Antonovka seedling. B.118 is easy to propagate in stool beds and is easily identified by its red leaves and bark (9). Morden 56-4 (MO.56-4) is an open-pollinated seedling of *Malus robusta* 5. Nothing is known of its performance as a rootstock, but it roots easily and was selected in a cold site. The clone I.48-41, from the North Caucasus Institute of Horticulture and Viticulture, Krasnodar, is reportedly comparable to M.26

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