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CLONAL SELECTION IN APPLE (*MALUS DOMESTİCA* BORKH CV. AMASYA)

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Abstract

A study was carried out using the apple populations grown in Amasya, Tokat and Samsun ecological conditions between 1997 and 2000. In the first year, 51 apple types were selected on which the studies have been concentrated. In the following observations, 27 types were selected as superior types and these were taken under genetic protection. At the end, 11 types suitable for the aims were selected using weight – based ranking method and then each clone grafted on four different rootstocks which will be used in further experiments.

Introduction

Turkey is one of the leading apple producing countries in the world with a production of 2,500,000 tons per year (Anon., 2000). Turkey which has a suitable climate for apple growing has a big apple gene potential as a result of having a wide richness of apple types and cultivars through a long historical period. Acording to Özbek (1978), 460 apple cultivars have been grown in different parts of Turkey. Apple cv. Amasya which is a winter cultivar is the widest - grown standard cultivar amongst these cultivars.

Fruits of Amasya, which has originated in Anatolia are medium sized (80-100 g/per fruit), slighly wide around the middle part of the fruit, having thin endocarp, hard fleshed, waxy, dark coloured at one side that is exposed to the sun; having light red colour on the other sides on a green ground. Fruit flesh is slightly greenish white, sweet, juicy and crackly when ripen. The fruits, harvested in the second week of September or at the beginning of October, can be safely stored in the convenient storing conditions up to May. Cv. Amasya apple bears fruits every other year, the condition known as alternate bearing. İt is widely grown almost in every region of Turkey (Özbek, 1978; Öz *et. al.*, 1991). The tendency of the growers to this cultivar has been changed due to its alternate bearing habit and they switched to grow other apple cultivars, mainly foreign ones. In recent years, even in Amasya province which is the origin of Amasya apple cultivar, the orchards have been dismounted and replaced with cherry or sour cherry fruit cultivars. The rate of this replacement has been increasing every year and Amasya has reached the point of eradication. The Black Sea region has only been producing 6.8% of total apple production of Turkey, although it has 12.52% of the apple trees in the country. This is a sign for not obtaining enough yield of apple from this region.

Eltez & Kaşka (1985) carried out a selection study on the alternate bearing problem of apple cv. Amasya around Niğde and nearby towns. After a five-years study, they selected ten types of apple cv. Amasya having superior characteristic such as having high resistance to cold storage conditions and these types were named as Kaşel apples. Kaşka & Küden (1992), indicated that Kasel 20, Kaşel 23 and Kaşel 37 types showed positive characteristics on different rootstocks in a study carried out to determine the behavior of

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Kaşel apples on different clonal rootstocks at Pozantı Agricultural Research Center of the Cukurova University after the year of 1984. In 1985, an experiment was carried out on Kaşel 37, Golden Delicious, Starking Delicious and Granny Smith apple cultivars at Tokat Fruit Growing Center. On M9, MM106, MM111 and seedling rootstocks, yield of Kaşel 37 was lower than the other apple cultivars (Anon., 1994, 1995).

Nes & Hjeltnes (1993), studied 25 clones of cv. Akero obtained by selection. In this study, the clones were found to be superior in terms of yield, fruit colour and size examined for 8 years by recording total and marketable yield as well as the amount of the first class fruits. Noiton & Shelbourne (1992), determined the strategy of quantitative genetics in apple breeding in a study carried out on 500 open- pollinated commercial cultivars.

Alekseev (1990), carried out a study on clonal selection of apples around Leningrad. In a study on the types selected from those having red fruit colour, spontaneous mutants showed that fruit colour of the types changed from light brown to orange and red. The promising red coloured clones obtained from this study viz., Korichane Dynchatoe, Grushovka, Moskovkaya Krasnaya and Naliv Rozovyi were used in fruit colour breeding. Cociu *et al.*, (1989), investigated 7 different apple varieties, crossed with Romania apple, resistance to *Venturia inaequalis* and *Podosphera leucotricha* as well as fruit quality since 1950's. The progenies of M. Zumi, M. Kadio and M. Floribunda showed required characterictics. In this study, Romus 1, Romus 2, Romus 3, Voinea and Generos were obtained by back-crossing of the above progenies with Starking Delicious and Jonathoan apple cultivars.

In this study, it was aimed to select apple types which have smooth fruit shape, good fruit quality, good skin colour and having no alternate bearing among the apple population in Amasya, Tokat and Samsun provinces. It was also aimed to increase the tendency of growing Amasya apple cultivar by supplying required types. In addition, genetic resources of superior types will be taken under protection.

Materials and Methods

The apple populations in Amasya, Tokat and Samsun Provinces were the materials of this study. Clonal selection method has been used and each tree has been referred as a type. The types used in the study were determined by means of finding out the spread areas of cv. Amasya apple before and during harvest time in co-operation with Amasya , Tokat and Samsun Agricultural units in provinces and districts of the mentioned areas in 1997.

Determination of the types was based on the characterictics of fruit quality and the case of alternate bearing, and family tree of the types was constituted for each type (Table 1). Pomological analyses were carried out on 25 fruits harvested from each type in addition to the analysis performed for fruit set observations at the stage of flower and small fruit in 1997, 1998 and 1999. In addition, flower and small fruit observations were repeated in the year of 2000 and these observations were utilised to discuss the result of the last three years of the study. Finally, general developmental charecteristics of the trees belonging to the selected types were also investigated.

Table 1. Family tree sample used in clonal selection of Amasya apple.

Orchard / location of tree	**Information regarding the tree**
Province:	Age:
District:	Rootstocks:
Village:	Propagation:
Latitute:	Canopy shape:
Longitute:	Development case:
Elevation (Altitude):	Pruning case :
Orchard owner:	Yield in previous year:
Local name:	Yield in this year:
Selection number:	Alternate bearing case:
Information regarding the orchards	Fruit harvesting date:
Establishment condition:	**Other remarks:**
Location of the tree:	
Soil tillage:	
Irrigation:	
Nutrition:	
Pests and Diseases:	
Soil type:	

In the sample fruits plucked at harvesting time; fruit weight (g), volume (cm^3), density (g/cm^3), % red colour of fruit skin, fruit width (mm), fruit length (mm), soluble solids (%), fruit firmness (kg), titreable acids (g/100 ml), seed number per fruit, carpel width (mm), length of longitudinal and cross-section of fruits and the place and elevations of the types were determined with Scout Master GPS Global Positioning System device (Childers, 1969; Eltez & Kaşka, 1985).

Yield, fruit weight and quality (fruit colour, sweetness, flavour, fruit shape etc.), alternate bearing and the characteristics of fruit development were taken into consideration in order to choose the convenient types.Weight - based ranking method was used to determine these characteristics and the results are given in Table 2.

Results and Discussion

Spread areas of apple (cv. Amasya) were determined and apple trees which had quality fruits and did not show alternate bearing were selected in some provinces and districts of Amasya, Tokat and Samsun in 1997. In the first year, 33 and 17 types of cv. Amasya apple were selected in Amasya and Tokat provinces respectively. In the first year, types suitable for the objectives of the present study could not be found in the provines of Samsun. In 1998, one more type was added to the total and a total of 51 types were taken into consideration. However, the types which showed alternate bearing according to the observations made during the first two year were eliminated from the total apple types and as a result of this, remaining 27 types were studied thereafter. The results obtained from eliminated types during the first part of the study are not reported here.

Table 2. The relative point, class value and points of the characteristics determined by means of weight based ranking method used in order to choose the types of apple cv. Amasya.

Parameters	Relative points	Class value	Points
Yield (kg/tree)	**10**	300.0-256.6	10
		256.5-213.2	8
		213.1-169.7	5
		169.6-126.2	3
		126.1- 82.7	1
Fruit weight (g)	**20**	147.5-161.8	10
		133.1-147.4	8
		118.7-133.0	5
		104.3-118.6	3
		89.9-104.2	1
Fruit quality (Fruit colour, sweetnes, flavour, fruit shape etc.)	**15**	Very good	10
		Good	8
		Acceptable	5
		Bad	3
		Very bad	1
Alternate bearing	**50**	Doesn't show	10
		Partly shows (% 60-90)	5
		Partly shows (% 30-60)	3
		Shows	1
Tree development	**5**	Very strong	3
		Strong	8
		Light strong	10
		Weak	5
		Very weak	1

Flower and fruit set observations

Flower and fruit set observations for four years for cv. Amasya apple types are given in Table 3. Some of the types had several flowers being distributed evenly throughout the tree canopy (05 AE 09, 15,21,22,31,32,60 AE 08, and 20). Flowering and fruit set in other types decreased during the following years or every other year. Some of the types showing partly alternate bearing also showed branch alternate bearing. Similar results were obtained from a study by Eltez & Kaşka (1985) on the selection of cv. Amasya apple in Niğde and nearby areas.

It was also observed that fruit set was irregular in the types showing irregular flowering. On the other hand, while fruits were small in size and had low quality because of over fruiting, they had bigger size and higher quality in the following year. This case increases the importance of fruit thining in the apple types with irregular fruit set.

Results of pomological analysis

Results of pomological analysis performed on the fruit samples taken twice from chosen types at harvesting during 1997, 1998 and 1999 are given in Table 4. Mean fruit weight of the types varied from 90.40 (05 AE 14) to 161.86 g (05 AE 13). Fruit volumes

of the types changed from 111.2 (05 AE 16) to 201.5 (05 AE 27) cm^3 while specific fruit weight was found to be between 0.67 (05 AE 14) and 1.00 (05 AE 11) g/cm^3. Fruit width and lenght varied from 52,2 to 72,6 mm and 43.0 to 90.9 mm, respectively. When fruit width and length were taken into consideration, it was found that fruits were round and oval in shape. Fruit firmness measurements showed that the values of this parameter were between 3.90 and 4.57 kg. This result also revealed that cv. Amasya apple types had also firm and strong fruit flesh. The soluble solids and acidity of the fruits varied from 11.93% and 0.201 g/100 ml to 16.34 and 0.577 g/100 ml, respectively. Carpel width of the fruits varied from 18.9 to 25.7 mm. Cross and lengthwise section of the fruit were found to be 1.0 – 3.0 and 4.0 – 7.0, respectively. Moreover, pomological analysis obtained from the present study were found to be in accordance with the results obtained from a study by Eltez & Kaşka (1985) on the selection of cv. Amasya apple in Niğde and nearby areas. It can be said that both differences either between the two studies or between the types may be due to the differences in genetical structure of the types, ecology and cultural applications.

Table 3. Flowering density and flower distribution in the canopy of cv. Amasya apple trees.

Apple types	Flowering %				Flower distribution in the canopy			
	1997	1998	1999	2000	1997	1998	1999	2000
05 AE 05	100	50	90	30	Balanced	Irregular	Balanced	Irregular
05 AE 08	100	25	75	40	Balanced	Irregular	Irregular	Irregular
05 AE 09	100	75	90	90	Balanced	Balanced	Balanced	Balanced
05 AE 10	100	40	100	40	Balanced	Balanced	Balanced	Irregular
05 AE 11	100	100	50	100	Balanced	Balanced	Balanced	Balanced
05 AE 13	100	80	80	90	Balanced	Balanced	Balanced	Balanced
05 AE 14	100	40	90	80	Balanced	Irregular	Balanced	Balanced
05 AE 15	100	80	100	100	Balanced	Balanced	Balanced	Balanced
05 AE 16	100	60	90	50	Balanced	Balanced	Balanced	Irregular
05 AE 18	100	70	90	50	Balanced	Balanced	Balanced	Irregular
05 AE 21	100	100	100	100	Balanced	Balanced	Balanced	Balanced
05 AE 22	100	100	90	100	Balanced	Balanced	Balanced	Balanced
05 AE 25	100	50	90	80	Balanced	Balanced	Balanced	Balanced
05 AE 26	100	30	70	70	Balanced	Irregular	Balanced	Balanced
05 AE 27	100	30	90	10	Balanced	Irregular	Balanced	Irregular
05 AE 28	100	80	70	80	Balanced	Balanced	Balanced	Balanced
05 AE 31	100	90	70	100	Balanced	Balanced	Balanced	Balanced
05 AE 32	100	90	80	90	Balanced	Balanced	Balanced	Balanced
05 AE 33	100	70	80	70	Balanced	Balanced	Balanced	Balanced
06 AE 04	100	50	50	100	Balanced	Irregular	Irregular	Balanced
06 AE 07	100	80	50	90	Balanced	Balanced	Irregular	Balanced
06 AE 08	100	80	90	100	Balanced	Balanced	Balanced	Balanced
06 AE 10	100	50	90	70	Balanced	Irregular	Balanced	Balanced
06 AE 12	100	60	90	100	Balanced	Balanced	Balanced	Balanced
06 AE 15	100	20	90	*	Balanced	Irregular	Balanced	*
06 AE 16	100	0	90	50	Balanced	-	Balanced	Irregular
06 AE 20	-	100	100	100	Balanced	Balanced	Balanced	Balanced

*Observations were not made because of the removal of the trees

Table 4. Results of pomological analysis in cv. Amasya apple (as means of 1997 and 1999)

Type No.	Fruit weight (g)	Volume (cm^3)	Specific weight (g/cm^3)	Redness in fruit skin (%)	Fruit width (mm)	Fruit length (mm)	Seed number per fruit	Soluble solids (%)	Firmnes (kg)	Cross section	Length wise section	Acidty (g/100 ml)	Carpel width (mm)
05 AE 05	119,20	135,0	0,883	58,5	58,0	48,0	6,50	13,22	4,35	2	4,5	0,201	-
05 AE 08	133,37	178,6	0,777	61,2	62,3	54,6	8,55	12,95	4,28	1,5	5,5	0,230	24,2
05 AE 09	118,29	157,5	0,751	66,0	59,3	50,0	6,90	13,37	4,16	1,5	6	0,300	21,8
05 AE 10	114,42	151,5	0,755	70,7	65,2	58,3	6,82	13,74	4,44	1,5	4	0,403	21,7
05 AE 11	121,77	121,8	1,000	58,3	60,8	48,4	7,00	13,18	4,29	1,5	6	0,311	23,4
05 AE 13	161,86	187,8	0,862	36,5	66,5	57,5	2,55	14,95	4,02	1,5	5	0,247	25,5
05 AE 14	90,40	135,0	0,670	69,0	52,2	43,0	8,10	12,65	3,90	2	4	0,371	20,6
05 AE 15	118,64	148,6	0,798	60,6	60,8	52,0	4,60	14,06	4,32	1,5	5,5	0,337	20,1
05 AE 16	100,98	111,2	0,908	54,4	61,8	47,8	6,70	12,41	4,05	1	4,5	0,274	21,3
05 AE 18	107,48	142,1	0,756	65,6	58,1	47,2	7,21	11,93	4,36	2	4,5	0,290	19,5
05 AE 21	130,46	162,0	0,805	82,9	60,4	56,1	4,00	14,12	4,25	1,5	7	0,303	21,2
05 AE 22	145,97	174,9	0,835	83,2	64,3	55,0	3,25	13,97	4,26	1,5	6	0,311	21,5
05 AE 25	138,09	166,8	0,828	55,3	63,1	55,0	4,60	12,61	4,36	1	5	0,351	23,8
05 AE 26	121,68	140,9	0,864	53,5	60,6	54,7	5,65	16,34	4,34	1,5	4	0,285	22,7
05 AE 27	149,97	201,5	0,744	69,5	65,4	58,5	5,10	13,36	4,32	1,5	6	0,546	24,1
05 AE 28	143,65	174,9	0,821	69,1	62,8	57,6	5,25	14,08	4,26	2	7	0,236	25,7
05 AE 31	126,56	143,8	0,880	61,3	66,4	62,7	1,40	14,35	4,49	3	4	0,267	-
05 AE 32	114,36	117,2	0,976	72,3	63,1	55,7	2,20	15,60	4,16	2	7	0,252	18,9
05 AE 33	131,29	161,2	0,814	82,7	67,6	61,7	3,40	12,65	4,41	2	4	0,224	-
60 AE 04	138,17	169,0	0,818	66,5	70,2	60,4	7,30	13,59	4,30	2	7	0,275	25,3
60 AE 07	122,19	146,3	0,835	87,2	66,1	90,9	6,05	13,47	4,34	1,5	5	0,315	22,0
60 AE 08	138,26	-	-	60,0	53,8	49,2	-	13,00	-	-	-	0,217	-
60 AE 10	126,63	141,3	0,896	71,4	61,6	50,9	5,95	12,72	4,03	1,5	4	0,226	22,1
60 AE 12	158,08	179,5	0,881	74,3	72,6	59,8	8,40	14,87	4,57	1	4	0,335	20,8
60 AE 15	117,34	129,8	0,904	52,8	60,9	56,2	7,55	12,29	4,39	1	4	0,577	21,8
60 AE 16	152,27	201,0	0,758	88,9	65,1	55,3	5,00	12,79	4,20	2,5	6,5	0,299	21,1
60 AE 20	136,70	168,8	0,810	72,0	72,1	61,5	7,60	12,00	4,30	2	4	0,302	24,2

* --- : Values were not taken into consideration because of insufficant fruit number.

Table 5. Weight-based ranking points of apple types, cv. Amasya, as mean value for three years.

Type	Yield	Fruit size	Quality	Alternate bearing	Tree development	Total	Ranking
05 AE 05	30	100	120	250	40	540	
05 AE 08	30	160	75	150	40	455	
05 AE 09	80	60	120	500	15	**775**	**7**
05 AE 10	50	60	75	250	40	475	
05 AE 11	10	100	120	250	40	520	
05 AE 13	80	200	75	250	40	**645**	**9**
05 AE 14	30	20	75	150	50	325	
05 AE 15	30	60	150	500	40	**780**	**6**
05 AE 16	10	20	75	150	50	305	
05 AE 18	30	20	75	250	50	425	
05 AE 21	10	100	250	500	50	**910**	**2**
05 AE 22	30	160	150	500	50	**940**	**1**
05 AE 25	30	160	120	250	40	600	
05 AE 26	30	100	75	150	40	395	
05 AE 27	30	200	120	150	40	540	
05 AE 28	10	160	75	250	40	535	
05 AE 31	30	100	120	500	50	**850**	**4**
05 AE 32	30	60	120	500	50	**760**	**8**
05 AE 33	30	100	120	250	50	550	
60 AE 04	50	160	120	250	40	**620**	**11**
60 AE 07	30	100	120	150	25	425	
60 AE 08	80	160	120	500	15	**875**	**3**
60 AE 10	100	100	75	250	40	565	
60 AE 12	10	200	120	250	40	**620**	**10**
60 AE 15	30	60	75	150	50	365	
60 AE 16	30	200	120	50	40	440	
60 AE 20	30	100	120	500	40	**790**	**5**

Fruit skin colour, which greatly influence consumers appeal has more importance for cv. Amasya apple, since it has been reported that cv. Amasya apple had a weak colouring in general. Relative red colour percentage of fruit skin was also determined and it was found that this value varied from 36.5% to 88.9% in the fruit samples of the chosen apple types. The fact that red colour percentage of the fruits with over 70% of the chosen apple types had appealing fruits and good consumer demand.

In the present study, it was also found that there was a positive linear relationship between orchard location and fruit colouring. Altitudes and co-ordinates of all the types investigated in the study were determined by the device of Scout Master Global Positioning System (GPS). The location of the types and their altitudes changed from 40 °N latitude and 400 to and 35-36 °W longitude 640 m respectively.

It has been reported that increasing altitude which increases the difference between day and night temperatures resulted in better skin colouring in fruits (Karaçalı, 1990). Red colour density of fruit skin also increased in the fruits of the trees located at high altitudes. For instance, the types at an altitude of 640 m (05 AE 21 and 05 AE 11) had better fruit skin colour compared to those at an altitude of 396m (05 AE 10 and 05 AE 11).

The results of weight-based ranking

The points of weight-based ranking which was estimated by taking the mean values for three years into consideration in apple types cv. Amasya are given in Table 5.

It is evident from Table 5 that 7 apple types showed no alternate bearing, and 11 types showed partial alternate bearing while the remaining types showed partial or certain alternate bearing more frequently. According to weight-based ranking, the points for yield, fruit size, quality, alternate bearing and tree development were found to be between 10-100, 20-200, 75-250, 50-500 and 15-50 for each parameter, respectively. When total points were taken in consideration, it was found that the points of the types varied from 305 to 940. The types, having a total point of 620 or above this point were considered to be available and to be studied further. For this aim, the types viz., 05 AE 22, 05 AE 21, 60 AE 08, 05 AE 31, 60 AE 20, 05 AE 15, 05 AE 09, 05 AE 32, 05 AE 13, 60 AE 12 and 60 AE 04 were selected. On the other hand, the other types were taken under protection by grafting them on the rootstocks, MM 106, in order to keep them as genetic resources in Amasya and Samsun.

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