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Original Research Article

Phenological and Pomological Characteristics of Local Apple (*Malus domestica* Borkh.) Genetic Resources of Siirt Region*

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ABSTRACT

This research was carried out on local apple varieties (*Malus domestica* Borkh.) that are grown in Şirvan, Pervari, Eruh districts and their villages in Siirt province. Fruit samples were taken between 2014-2015 from 21 different trees that are qualified, have high value in the market and preferred by local people. Phenological observations were recorded on selected trees and pomological properties were investigated on collected fruit samples. The budburst, beginning of flowering, flowering time, number of days from full bloom to harvest (FBD) and harvest date are recorded as phenological observations. According to the results, the budburst was between March 28th and May 3rd , the date of first flowering was between April 2nd and May 10th , the full of bloom was between April 9th and May 17th ,the end of flowering was between April 14th and May 23rd , the harvest date was between 11th of August and14th of October, and the number of days from full bloom to harvest (FBD) was between 113 and 149 days. According to phenological observations, fruit weight was between 20,45 and 73,42 g, fruit sizes were between 32,73 and 60,10 mm, fruit diameters were between 36,27 and 60,32 mm, fruit stalk length was between 4,23 and 26,16 mm, fruit stalk thickness was between 1,96 and 2,61 mm, the amount of soluble solids of fruits was between %6,032 and 13,24, the amount of titratable acid was between %0,85 and 6,10, the juice pH was between 3,13 and 5,37. In addition to above parameters, fruit peel color, fruit flesh color, fruit grittiness and taste were also determined.

Keywords: Apple, Phenology, Pomology, Morphology, Gene sources, *Malus domestica* Borkh., Siirt

INTRODUCTION

Eight homeland regions (gene center) for apple (*Malus domestica* Borkh.) have been determined in the world. Within these, China, Central Asia, and Near East are suggested as major gene centers of apple. It is possible to add North America t these gene centers due to its wide range of different species and varieties (Ozbek, 1978).

It is suggested that origin of Apple is South Caucasus where Anatolia is also located. Today, it has over 6590 varieties. Apple, which is a long season plant and it is possible to eat fresh every season thanks to developing storage techniques. It also has an important position for human nutrition (Ozbek, 1978).

Turkey has a wide range of apple cultivation at local and national level. Many of the national varieties and cultivars were analyzed for pomological characteristics. However, there are many other local varieties that are very valuable for genetic diversity and not evaluated for above characteristics. (Akca and Sen, 1990).

This study, carried out in Siirt Province where fruit cultivation has a long and historic importance, aims to identify high-quality local apple genotypes, grown in various regions of Siirt Province and define the phenological pomological and morphological characters of these genotypes. Therefore, the knowledge of apple genetic resources in Siirt will be acquired, and local apple genotypes, which are beginning to disappear will be given a chance to be preserved at in-situ and possibly ex-situ conditions. It would also lead to future related studies.

Local varieties which do not have high economic value usually consumed at local markets or just in a family holds great genetic values and are unique materials (Bostan and Sen, 1991). Therefore, it is an important priority for growers to study these genotypes and shed light on their characteristics, such as adaptability.

The most widely grown varieties of apples in our country are Amasya, Starking Delicious, Golden Delicious, Starkrimson, Starkspur Golden and Granny Smith respectively. Red Delicious, Granny Smith, and Golden Delicious, which were the most common varieties between the 1960s and 1980s, have gradually begun

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to lose popularity and leave their place to varieties such as Gala, Royal Gala, Fuji, Braeburn, Jonagold and Elstar (Kaska, 1997).

Wide range of varieties provide a source of breeding material for fruit breeders. Preservation of this gene stocks, by using them as breeding materials and revealing new values are among the main tasks of plant breeders. This variety should be selected according to efficiency, resistance to various diseases and pests, ability to resist certain climate and soil conditions (Guleryuz, 1979). Our local varieties with economic value and genetic stock need to be protected for genetic diversity or controlled by breeding to prevent the danger of being lost (Edizer and Gunes, 1997). Siirt province, which is located between 41º-57' East longitudes and 37º-55' North latitudes is located in the South Eastern Anatolia and surrounded by Şırnak and Van from the east, Batman and Bitlis from the north, Batman from the west, and Mardin and Şırnak from the South (Anonymus, 2005). Production of important fruit species in Siirt Province are given in Table 1.

Table 1. Fruit Production in Siirt Province (Anonim, 2015a)

Fruit Species	Area (da)	Amount (tone)
Pistachio	190.653	15.228
Grape	25.576	14.755
Pomegranate	5.402	3.586
Almond	513	213
Walnut	228	157

This study aims to prevent the loss of local apple genotypes which are thought to be missing commercial value, to identify the most qualified varieties in terms of fruit quality among many genotypes, to determine the phenological, pomological and morphological characteristics of these genotypes and to bring the determined apple genotypes into cultivation.

MATERIALS AND METHODS

Material

This study was conducted with the local apple genotypes/varieties in Siirt Province for two years between 2014 and 2015. The research materials were 21 local apple genotypes collected from the villages of Şirvan, Pervari and Eruh districts in Siirt Province.

Method

Phenological, Morphological and Pomological Properties

Phenological properties; Days to budburst, Pre-bloom, Full bloom, Post bloom, the start of harvest date and the number of days from full bloom to harvest were calculated.

Morphological properties; Age of the tree, canopy height, and canopy width, body circumference, estimated yield (kg/tree), tree habitus, tree growth strength, and periodicity status were measured/analyzed.

Pomological properties; Fruit weight (g), fruit length (mm), fruit diameter (mm), fruit shape index (length/width in 10 fruits, (flat; between 0.81-0.92, rounded; between 0.93-1.04, long; 1.05 and over) was determined and average values were recorded (Guleryuz, 1972). Additionally, fruit stalk length, fruit stalk thickness (mm), fruit seed sizes (mm), seed count (piece/fruit), seed weight (g) were also calculated.

Chemical properties; pH, amount of soluble solids of fruit (ASSF %), titratable acidity (malic acid as %) were calculated. Titratable acidity was calculated from the type of malic acid commonly found in apples according to Kılıc *et al.* (1991).

Sensory observation; Fruit taste (Sour, pale, sweet), flavor; (poor, medium, good), hydrangea; (low-water, medium-water, high-water) were determined via sensory observation. Fruit flesh color and fruit peel color were determined by observations and comparisons.

Evaluation of genotypes according to the modified graded method

Genotypically modified graded method which identifies the promising genotypes, were applied to the averages of the results from 2014 and 2015 (Sen *et al.*, 1992). The properties, that examined in the fruits, the limits of properties, the coefficients of the properties and significance level are given in Table 7. Weighted total scores of each genotype and scores of the class of qualities (properties) that examined in each genotype were multiplied by relative scores and total scores calculated. The highest score was selected as the promising genotype.

RESULTS

Twenty-one local genotypes were evaluated for phenological, morphological and pomological characteristics and results are given below. The averages of the values obtained based on the results of observations belongs to two years are given and also some fruit properties of the examined genotypes are presented.

Phenological Results; Budburst, Pre-bloom, Full bloom, Post bloom, ending of harvest and the number of days from full bloom to harvest are given in Table 2. According to results; genotypes with the earliest budburst were 56 ŞR 01 and 56 ŞR 06 on March 28. The genotype with the latest bud break was 56 ŞR 15 on May 3. The earliest blooming genotypes were 56 ŞR 01 and 56 ŞR 05 on April 2 and the genotype with the latest pre-bloom was 56 ŞR 15 on May 10. The genotype with the earliest full bloom was 56 ŞR 14 on April 9 and the genotype with the latest full bloom was 56 ŞR 15 on May 17. The earliest cap fall was on the genotype 56 ŞR 01 on April 14, The latest cap fall was on the genotype56 ŞR 15 on May 23. The earliest harvest was on 56 PR 01 on Agust 11, while the latest harvest was 56 ŞR 15 on October 14. The least number of days from full bloom to harvest was on genotype 56 ER 01 with 113 days. The maximum number of days from full bloom to harvest was on 56 ŞR 06 with 149 days.

Table 2. Significant Phenological Observations of the Examined Apple Genotypes.

Genotype Code	Local names	Bud burst	Pre-bloom	Full bloom	Post-bloom	End of Harvest	NDFH
56 ŞR 01	Helesan-1	28 March	2 April	10 April	14 April	15 Agust	127
56 ŞR 02	Helesan-2	15 April	20 April	28 April	2 May	7 Sept.	132
56 ŞR 03	Helesan-3	14 April	19 April	27 April	1 May	9 Sept.	135
56 ŞR 04	Helesan-4	29 March	3 April	13 April	17 April	25 Agust	137
56 ŞR 05	Helesan-5	28 March	2 April	12 April	16 April	3 Sept.	142
56 ŞR 06	Helesan-6	30 March	4 April	16 April	18 April	12 Sept.	149
56 ŞR 07	Helesan-7	1 April	6 April	17 April	19 April	10 Sept.	146
56 ŞR 08	Helesan-8	30 March	4 April	15 April	19 April	1 Sept.	139
56 ŞR 09	Reşap	2 April	7 April	17 April	21 April	8 Sept.	144
56 ŞR 10	Hese-1	26 April	1 May	12 May	16 May	6 Sept.	118
56 ŞR 11	Hese-2	23 April	27 April	4 May	9 May	1 Sept.	121
56 ŞR 12	Hese-3	9 April	15 April	23 April	29 April	23 Agust	123
56 ŞR 13	Hese-4	14 April	22 April	4 May	8 May	30 Agust	119
56 ŞR 14	Hese-5	24 March	2 April	9 April	15 April	13 Agust	127
56 ŞR 15	Sevaçali	3 May	10 May	17 May	23 May	10 Oct.	147
56 ER 01	Sevazer	26 April	4 May	9 May	14 May	29 Agust	113
56 ER 02	Benekli	4 April	9 April	16 April	21 April	14 Agust	121
56 PR 01	Sevaşerin	20 April	25 April	1 May	7 May	11 Agust	123
56 PR 02	Sevatırş	7 April	12 April	19 April	25 April	18 Agust	122
56 PR 03	Ovacin	11 April	16 April	23 April	29 April	26 Agust	126
56 PR 04	Sohrık	5 April	10 April	17 April	23 April	17 Agust	123

Morphological Results; Body circumference, canopy width and canopy height, tree age, tree habitus, are given in Table 3. According to results; the lowest body circumference was on 56 ER 01 with 32 cm and the widest body circumference was on 56 ŞR 01 to with 121 cm. Considering the canopy width and height, it was observed that the trees showed a wide variation from the patelliform to perpendicular. Canopy width was

observed between 1,5 (56 ŞR 05) and 5 m (56 ŞR 14). Canopy height was observed between 2 m (56 ER 01) and 5 m (56 ŞR 08 and 56 ŞR 15).

Table 3. Important Tree Properties of the Apple Genotypes.

Genotype code	Local names	Body circumference (cm)	Canopy width (m)	Canopy height (m)	Tree age (Year)	Habitus
56 ŞR 01	Helesan-1	121	3	4	35	Semi-perpendicular
56 ŞR 02	Helesan-2	43	2	3	25	Patelliform
56 ŞR 03	Helesan-3	83	4	3	30	Patelliform
56 ŞR 04	Helesan-4	92	3	4	25	Perpendicular
56 ŞR 05	Helesan-5	86	1,5	2,5	25	Patelliform
56 ŞR 06	Helesan-6	95	3	4	30	Semi-perpendicular
56 ŞR 07	Helesan-7	92	4	3	40	Patelliform
56 ŞR 08	Helesan-8	56	2	5	30	Perpendicular
56 ŞR 09	Reşap	72	3	4	35	Patelliform
56 ŞR 10	Hese-1	83	4	3	25	Patelliform
56 ŞR 11	Hese-2	65	3	3	25	Patelliform
56 ŞR 12	Hese-3	75	4	4	20	Patelliform
56 ŞR 13	Hese-4	83	4	3	30	Semi-perpendicular
56 ŞR 14	Hese-5	87	5	4	40	Perpendicular
56 ŞR 15	Sevaçali	57	4	5	30	Semi-perpendicular
56 ER 01	Sevazer	32	3	2	15	Perpendicular
56 ER 02	Benekli	57	3	4	25	Patelliform
56 PR 01	Sevaşerin	69	4	4	20	Patelliform
56 PR 02	Sevatırş	50	2	3	30	Patelliform
56 PR 03	Ovacin	39	4	4	20	Perpendicular
56 PR 04	Sohrık	37	3	4	20	Semi-perpendicular

Pomological Results; The values of some important fruit properties of 21 apple genotypes from the year 2014-2015 are given in Table 4 and 5.

Table 4. Some Important Fruit Characteristics of the Apple Genotypes.

Genotype Code	Fruit Weight(g)	Fruit diameter (mm)	Fruit Height (mm)	Fruit Stalk Length (mm)	Fruit Stalk Thickness (mm)	Fruit Shape Index	FSPD (mm)	FFPW (mm)	FFPD (mm)
56 ŞR 01	72,49	60,87	61,15	12,66	2,37	1,00	11,20	26,24	11,21
56 ŞR 02	32,80	51,53	41,02	7,63	2,44	0,79	10,13	20,83	10,76
56 ŞR 03	69,01	51,27	52,60	17,72	2,42	1,02	11,75	26,20	13,94
56 ŞR 04	61,22	51,18	49,79	10,94	2,09	1,02	9,50	23,38	11,43
56 ŞR 05	31,24	40,12	41,13	5,08	2,42	1,02	8,32	25,23	11,99
56 ŞR 06	26,38	40,25	40,63	8,34	2,42	1,00	12,49	23,00	12,03
56 ŞR 07	25,53	40,30	30,48	8,88	2,08	0,75	12,20	23,02	9,27
56 ŞR 08	43,94	49,82	40,41	11,92	2,27	0,81	9,61	24,14	11,07
56 ŞR 09	46,35	60,18	50,10	8,91	2,20	0,83	11,25	18,29	8,81
56 ŞR 10	42,35	56,44	43,72	24,31	2,18	0,77	8,64	18,55	8,20
56 ŞR 11	43,60	48,69	40,69	8,59	2,11	0,83	8,85	12,79	6,31
56 ŞR 12	28,90	40,54	37,82	13,56	2,22	0,92	8,88	12,73	8,57
56 ŞR 13	37,68	44,37	49,62	12,58	2,22	1,11	9,30	18,00	10,86
56 ŞR 14	26,96	40,82	34,92	4,18	2,28	0,85	9,11	16,77	11,43
56 ŞR 15	29,50	46,66	48,63	9,17	2,18	1,03	13,19	27,29	16,86
56 ER 01	32,86	48,98	50,97	23,54	2,22	1,03	8,39	9,78	11,45

56 ER 02	43,60	55,94	49,21	20,74	2,12	0,87	8,72	10,67	8,05
56 PR 01	28,90	48,19	39,75	13,65	2,41	0,82	8,47	10,96	9,07
56 PR 02	37,68	50,89	45,71	25,71	1,89	0,89	8,41	10,96	9,47
56 PR 03	26,96	48,86	49,48	11,94	2,34	1,01	7,55	19,00	6,59
56 PR 04	29,50	36,78	32,13	18,28	2,26	0,87	8,11	20,44	5,91

FSPD: Fruit Stalk Pitch Depth, FFPW: Fruit Flower Pitch Width, FFPD: Fruit Flower Pitch Depth

Table 5. Some Important Fruit Characteristics of the Apple Genotypes.

Genotype code	WFSA (mm)	LFSA (mm)	Seed height (mm)	Seed widht (mm)	Seed Thickness(mm)	Seed Counts (pieces)	Seed weigh (g)	FPT (mm)
56 ŞR 01	28,79	23,20	7,09	3,91	2,39	3,35	0,53	0,35
56 ŞR 02	31,52	24,10	7,30	4,17	2,28	4,10	0,37	0,37
56 ŞR 03	19,81	24,20	8,51	4,38	2,25	6,35	0,61	0,29
56 ŞR 04	25,27	22,54	7,94	4,22	2,36	5,80	0,59	0,28
56 ŞR 05	28,32	25,50	8,66	5,55	2,34	4,40	0,49	0,28
56 ŞR 06	23,24	21,59	8,02	4,09	2,64	3,05	0,27	0,30
56 ŞR 07	37,05	27,75	8,35	6,77	2,47	3,05	0,38	0,33
56 ŞR 08	18,40	17,95	7,60	8,12	2,33	2,00	0,31	0,31
56 ŞR 09	26,14	17,68	7,91	5,39	2,63	3,55	0,37	0,33
56 ŞR 10	25,90	21,86	7,24	4,58	2,26	2,45	0,31	0,36
56 ŞR 11	23,42	18,56	6,62	4,30	2,43	4,20	0,44	0,21
56 ŞR 12	21,95	22,11	7,26	3,60	1,50	2,65	0,30	0,25
56 ŞR 13	19,60	18,65	8,10	3,98	2,20	2,55	0,33	0,28
56 ŞR 14	26,57	23,73	7,56	5,72	2,18	1,20	0,33	0,43
56 ŞR 15	26,80	24,14	7,63	4,42	5,27	2,00	0,31	0,40
56 ER 01	17,52	20,66	6,53	3,80	4,41	1,75	0,21	0,21
56 ER 02	18,40	20,96	7,79	3,40	1,37	1,55	0,24	0,22
56 PR 01	19,56	25,72	7,56	4,57	1,69	2,50	0,33	0,24
56 PR 02	22,59	24,10	8,74	3,82	2,30	2,20	0,31	0,26
56 PR 03	32,01	28,06	6,85	4,16	1,83	4,05	0,44	0,32
56 PR 04	25,54	20,51	7,31	3,50	2,42	3,30	0,33	0,18

WFSH: Weight of Fruit Seed Aperture, **LFSH:** Lenght of Fruit Seed Aperture, ,**FPT:** Fruit Peel Thickness

Chemical Results; amount of soluble solids of fruit, pH value, Titratable acidity amount of 21 apple genotypes, that examined in 2015, are given in Table 6.

Table 6. Some Chemical Properties of the Apple Genotypes.

Genotype code	Local names	ASSF (%)	pH	VTA (%)
56 ŞR 01	Helesan-1	10,00	4,55	1,20
56 ŞR 02	Helesan-2	10,00	3,65	3,60
56 ŞR 03	Helesan-3	8,60	4,46	1,90
56 ŞR 04	Helesan-4	7,50	3,76	3,60
56 ŞR 05	Helesan-5	8,30	5,37	0,80
56 ŞR 06	Helesan-6	10,60	5,24	0,80
56 ŞR 07	Helesan -7	6,30	3,95	2,90
56 ŞR 08	Helesan -8	10,60	4,44	2,10
56 ŞR 09	Reşap	7,50	3,31	3,10
56 ŞR 10	Hese-1	9,00	3,64	2,70
56 ŞR 11	Hese-2	12,00	3,25	3,20
56 ŞR 12	Hese-3	9,00	3,41	2,10
56 ŞR 13	Hese-4	13,00	3,22	3,00
56 ŞR 14	Hese-5	11,00	3,44	2,60
56 ŞR 15	Sevaçali	9,40	3,28	2,40
56 ER 01	Sevazer	12,00	4,14	2,20
56 ER 02	Benekli	11,00	3,91	4,00

56 PR 01	Sevaşerin	6,00	4,06	1,20
56 PR 02	Sevatırş	9,00	3,13	4,10
56 PR 03	Ovacin	10,00	3,84	3,20
56 PR 04	Sohrık	10,00	3,76	3,30

ASSF:, Amount of Soluble Solids of Fruit, **VTA:** Value of Titrable acity (%)

The pH values in our study varied between 3.13 (56 PR 02) and 5.37 (56 ŞR 05). Previously Kaya (2008) reported a study on apple cultivars in the Van province and Edremit and Gevaş districts and found the pH values ranged between 3.16 and 4.55. Balta and Uca (1996) found that the pH values of a study were ranged between 3.34 and 4.68, which was carried out with apple varieties from Iğdır province. Özrenk *et al.* (2010), reported pH values were between 3.40 and 4.60 on a study conducted on the local apple varieties grown in Çatak and Tatvan districts. Kazankaya *et al.* (2009), reported pH values between 3.43 and 4.08 for the apple varieties grown in Erciş and Muradiye districts. Kaya and Balta (2013), found pH values between 3.14 and 4.79 on a study carried out on the fields of the central Van province, Edremit, and Gevaş districts. Sen *et al.* (1992), found the pH values between 3.89 and 5.44 in their study that carried out with local apple varieties grown in Ahlat district. As a result, our study shows a harmony with other studies previously reported.

Selection of Local Apple Genotypes

Table 7. 21 Genotypes scores according to average data in 2014-2015 and total scores obtained from the grading criteria.

Sample number No	Genotypes	Local names	Fruit weight (gr)	Fruit diameter	ASSF (%)	VTA (%)	Total score
1	**56 ŞR 01**	**Helesan-1**	**315**	**180**	**125**	**20**	**640 (3)**
2	**56ŞR 02**	Helesan-2	35	100	125	180	440
3	**56 ŞR 03**	Helesan-3	315	100	125	20	560
4	**56 ŞR 04**	Helesan-4	245	100	25	180	550
5	**56 ŞR 05**	Helesan-5	35	20	25	20	100
6	**56 ŞR 06**	Helesan-6	35	20	125	20	200
7	**56 ŞR 07**	Helesan -7	35	20	25	100	180
8	**56 ŞR 08**	Helesan -8	105	100	225	100	530
9	**56 ŞR 09**	**Reşap**	**175**	**180**	**125**	**180**	**660 (2)**
10	**56 ŞR 10**	Hese-1	105	180	125	100	510
11	**56 ŞR 11**	**Hese-2**	**105**	**100**	**225**	**180**	**610 (4)**
12	**56 ŞR 12**	Hese-3	35	20	125	100	280
13	**56 ŞR 13**	Hese-4	105	20	225	100	450
14	**56 ŞR 14**	Hese-5	35	20	225	100	380
15	**56 ŞR 15**	Sevaçali	35	100	125	100	360
16	**56 ER 01**	Sevazer	35	175	225	100	535
17	**56 ER 02**	**Benekli**	**105**	**180**	**225**	**180**	**690 (1)**
18	**56 PR 01**	Sevaşerin	35	100	25	20	180
19	**56 PR 02**	Sevatırş	105	100	125	180	510
20	**56 PR 03**	Ovacin	35	100	125	180	440
21	**56 PR 04**	Sohrık	35	20	125	180	360

Genotypes that highlighted as bold were determined as promising genotypes

CONCLUSIONS

Apple varieties grown in and around the Siirt province were evaluated based on important characteristics such as fruit weight, fruit flavor, amount of soluble solids and fruit diameter and graded with modified grading method. Some of the genotypes were promising, among those, 56 ER 02, 56 ŞR 11, 56 ŞR 01, and 56 ŞR 09 was found to be more superior to other genotypes (Figure 1). These genotypes are thought to be suitable for apple cultivation. It has been found in the study, that apple cultivation is not in closed gardens. It is usually found on the sprawling, spontaneously or grafted trees on fields and roadsides.

Our country can be an expert on apple export market in the world. It would be achieved with the production of high-quality varieties and use of standard varieties suitable for each region. Identification of local genotypes that can be candidates of the standard apple varieties is very important in terms of preserving the genotypes carrying quality traits, especially for future breeding studies. It is thought that the promising genotypes that we have identified can be used as pedigree materials in subsequent breeding studies.

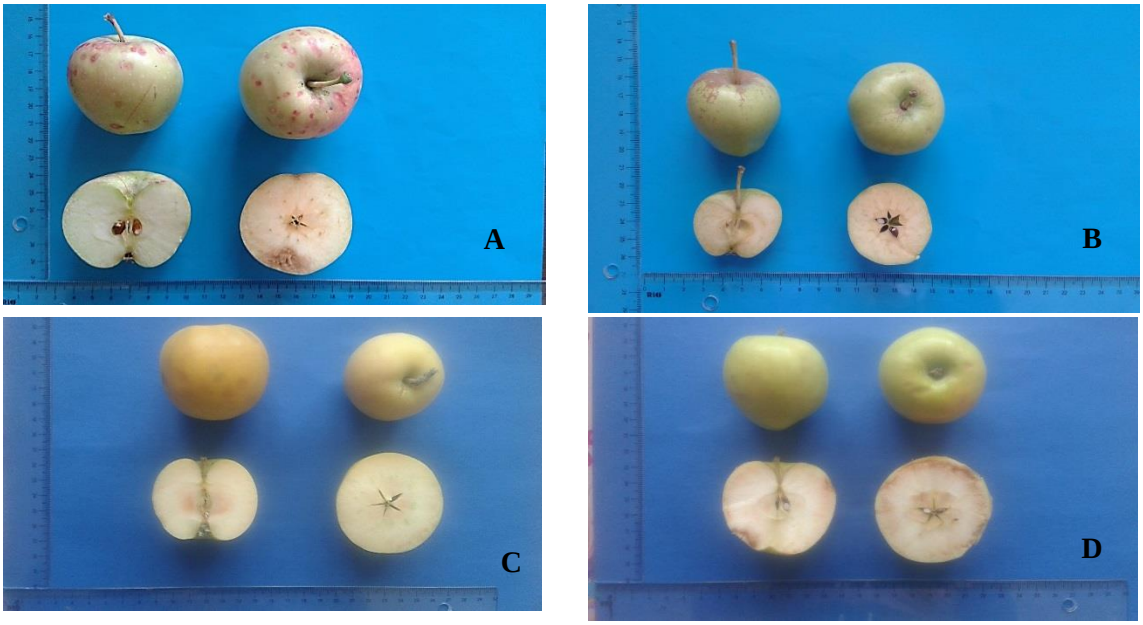

Figure 1. Images of some promising apple genotypes. a) 56 ER 02 b) 56 ŞR 11 c) 56 ŞR 01 d) 56 ŞR 09.

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