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SOME MORPHOLOGICAL CHARACTERISTICS OF FRUITS AND LEAVES OF *MALUS SYLVESTRIS* (L.) MILL. GENOTYPES FROM SOUTHERN OLTENIA

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Abstract

The purpose of this paper was to identify and analyse the morphological characteristics of European crab apple fruits and leaves within a forest ecosystem from South-West part of Oltenia region, Romania. Genotypes were studied for their individual characteristics, fruit morphological characteristics, and leaf morphometric parameters. In terms of fruit characteristics the fruit height ranged between 16.64 mm – 35.47 mm, fruit diameter between 19.47 mm – 43.38 mm and fruit weight between 3 g to 26 g. Fruit shape index, had a mean value of 0.84, and variation limits between 0.61 to 1.12. The coefficient of variation had values between 6.83 – 13.33% for fruit height, 4.93 – 14.76% for fruit diameter, 14.10 – 41.70% for fruit weight and 4.87 – 8.00 for fruit shape index. The leaves morphometric characteristics varied between 8.02 cm^2 and 48.48 cm^2 for leaf surface area, 3.86 cm to 10.00 cm for leaf length and 2.67 cm to 6.11 cm for leaf width. The coefficient of variation ranged between 9.63 – 21.25% for leaf surface area, 7.50 – 12.26% for leaf length, 6.57 – 12.80% for leaf width and 7.43 – 14.87% for leaf length/width ratio. Variability identified from one genotype to another indicates potential for selection of individuals with superior characteristics.

Key words: European crab apple, Fruits, ImageJ, Leaves, Measurements.

Introduction

Malus sylvestris (L.) Mill. – European crab apple, wild apple or forest apple is part of the *Rosaceae* family and it is the only apple species native to Central and Western Europe being also a very rare one found at the edge of forests or in scattered individuals (Coart *et al.*, 2006; Reim *et al.*, 2012; Wagner *et al.*, 2014; Michalak *et al.*, 2015). It can reach up to 15 m or more in height, although it may sometimes look like a shrub, it is most common a tree, with more or less thorns (assumed to be actually spiky shoots according to Reim *et al.*, 2012) and a diameter of up to 50 cm or even up to 120 cm in mature older trees (Worrell *et al.*, 2018) living up to 80 to 100 years. Some important characteristics in indentifying the species are very dense crowns, with irregular shape, many individual twigs, gray-brown peeling off bark which during winter period has a distinctive dark slate-grey colour (Worrell *et al.*, 2018). When in flower (mid-late May) they can be spotted by the pink to white flowers, which come out a week or so before hawthorn. The flowers of 3-4 cm in diameter, with 5 petals, 5 sepals (3-7 mm) and 5 seminal lodges, attract insects with their sweet scent. Leaves with various shades of green, are ovate, elliptical serrate or crenate with a rounded base or cuneate, glabrous to slightly hairy when matured, towards the edges (Stephan *et al.*, 2003), almost hairless, less than 6 cm, oval with small triunghiular teeth according to McInerny & Gray (2018) stiff and somewhat shiny on both surfaces (Worrell *et al.*, 2019). They can be found alternately along the branch with a pointed tip that leans to one side. The fruits are astringent, glabrous, of variable sizes, of yellow-greenish color, with a diameter between 2 to 3.5 cm (2-4 cm according to Huxley *et al.*, 1992). Tardío *et al.*, (2020) states as a classical method in differentiating the wild apple the lack of hairiness on the undersides of the leaves, lower fruit width, often bellow 3 cm, the absence of red fruits skin colour and the astringent taste. Petrokas & Stanys (2008) mentions as a major morphological character in identifying *M. sylvestris*, the slightly hairiness of the inferior part of leaves when young and lack of hairiness in autumn, thorns on twigs, colour and fruit taste. Hassan *et al.*, (2017) mentions most of analysed fruits as globose to obloid and ellipsoid shape, of yellow – green colour, mostly firm and acidic to bitter taste. The polenisation of European crab apple is made by insects and the seeds are spread by birds and mammals. It can be found at the edge of forests as a solitary species, in small groups or inside them, mainly in oak forests. It is a species less demanding on soil type but it has high requirements over light intensity, a factor that can influence the fruit production (Hassan *et al.*, 2017). It can be considered seriously endangered due to hybridization (Wagner, 2011) with the domestic apple, it is one of the most endangered tree species in Lithuania (Petrokas & Stanys, 2008), and endangered in Germany, Czech Republic and Belgium (Cornille *et al.*, 2014). It can be used as a rootstock for apple varieties, but also as an ornamental plant. Šebek (2013) and Čurović *et al.*, (2019) states that genotypes with least fruit mass are more commercial then the domestic varieties in terms of generative rootstock production. Hassan *et al.*, (2017) mentions as an important parameter in the evaluation of fruit characters fruit colour, which correlates with environmental conditions, being influenced by temperature, location, light penetration and plant habit. Michalak *et al.*, (2015) lists wild apple as an important species due to its ecological and economical perspective.

The aim of this paper was to identify and evaluate the morphological characteristics of European crab apple fruits and leaves from spontaneous flora in order to identify superior genotypes useful for practice and improvement.

Materials and Methods

European crab apple (*M. sylvestris* Mill.) was found in Bratovoesti forest, located in South-West part of Romania, Oltenia region, Dolj County (44°05'19.5"N 23°54'03.5"E). In terms of climate characteristics according to Cojoacă & Niculescu (2018), the natural environment in which the research was carried out has a continental climate, with average rainfall of roughly 500mm/year and a temperature amplitude of over 25˚C. Regarding soil characteristics, the forest ecosystem is located on loess, which led to the formation of alluvial soils and reddish brown luvic soils (Cojoacă & Niculescu, 2018). After identification of genotypes, a selection was made based on their fruit bearing, meaning that only genotypes with fruit load were taken into study. 100 fruits from each genotype were harvested at fruit ripe for picking phenophase (BBCH 87) for morphological laboratory analysis. Also the sixth leaf from the annual shoot was collected with a total of 20 leaves from each genotype for surface area, length and width parameter analysis.

Stem diameter was determined by measuring the stem circumference at ground surface level with a measuring tape, afterwards radius and diameter was calculated. Trunk height was determined using measuring tape from the ground surface level until the first primary branch. GPS coordinates and altitude were determined using GoogleEarth software. Measurements such as height, diameter and fruit weight were made. The fruit height and diameter were determined with the high precision electronic calliper and the total fruit weight with the KERN EMB 200-2 analytical balance. Fruit shape index (FSI) was determined by the ratio between the fruit height and fruit diameter. Leaves were collected according to the method used by Cosmulescu *et al.*, (2020) and were analised using ImageJ 1.53c software according to the procedure described by Ahmad *et al.*, (2015) and Cosmulescu *et al.*, (2020).

The obtained data from all measurements was processed in Excel descriptive statistical program. The average of 100 fruits harvested from each genotype were expressed as mean and standard deviation. The coefficient of variation was determined by the formula: CV=SD/X*100.

Results and Discussions

All studied genotypes phenotypic characteristics can be found in table 1, with a description of basal stem diameter, trunk height, altitude and GPS coordinates. Basal stem diameter was of 9.86 cm at Ms8 and 27.05 cm at Ms6, the largest of all genotypes, with a mean at studied genotypes of 18.42 cm and a coefficient of variation of 32.79%. Results were in correlation with those obtained by Ganea (2014) at studied genotypes from Republic of Moldova (4 cm to 50 cm) and with those obtained by Čurović *et al.*, (2019) with a mean stem diameter of 26.00 cm at studied genotypes from Montenegrin forests. In terms of trunk height, the mean value was of 166.89 cm with wide variation limits between 22.00 cm to 332.00 cm, and a coefficient of variation of 62.11%. The high value of the variation coefficient can be due to the different age of the genotypes. All studied genotypes were identified at an altitude of 58 m – 62 m. In table 2 can be found the data processed in descriptive statistics program regarding fruit morphological characteristics, such as fruit height, diameter, fruit weight and fruit shape index. The height of the fruits or fruit length ranged between 16.64 mm at Ms14 to 35.47 mm at Ms17, results close to those obtained by Šebek (2013) with 22.12 mm to 38.19 mm. Average value for this characteristic at studied fruits was of 24.34 mm. Drvodelić *et al.*, (2015) analysed three fruit height categories with an average of 20.85 mm for small fruits, 29.05 mm for medium fruits and 33.16 mm for large fruits, based on this classification and on the average value obtained in this study, the analysed fruits can be classified as small to medium fruits. Hassan *et al.*, (2017) had values between 11.4 mm and 52.1 mm in terms of fruit height at wild apple accesions from Kashmir region. Reim *et al.*, (2012) reported values for wild apple fruit sizes between 18 mm to 51 mm in East Ore Mountain. The minimum value regarding the fruit diameter obtained in this study was 19.47 mm at Ms14, lower than the result of Šebek (2013) of 27.78 mm, and the highest was 43.48 mm at Ms1 (similar with Šebek 2013, result of 42.81 mm), close results with those obtained by Drvodelić *et al.*, (2015) which had an average value of 24.09 mm for small fruits category, 34.64 mm for medium size category and 40.59 mm for large size category.

Mean value for fruit diameter was 29.09 mm (Table 2) which can be classified as small to medium sized fruits after Drvodelić *et al.*, (2015) classes. According to Cornille *et al.*, (2014) the fruit diameter of European crab apple is between 10 mm to 30 mm while Mateja *et al.* (2015) states that the diameter from fruits found in Slovenia is less then 35 mm. Another study mentions diameter less than 40 mm after McInerny & Gray (2018) and an average of 28 mm in genotypes studied by Worrell *et al.*, (2019). In Kashmir region, Hassan *et al.*, (2017) had average values for wild apple fruits diameter between 11.7 mm and 64.2 mm. According to Šebek (2018) fruit mass is an inherited genetic characteristic. In terms of fruit weight (Table 2), the highest value was of 26 g corresponding to Ms1 and the lowest of 3 g at Ms14 and Ms15, results that confirm Drvodelić *et al.*, (2015) study divisions according to average fruit weight, small fruits (< 10 g with an average value of 5.78 g), medium fruits (10-20 g with an average value of 14.96 g) and large fruits (> 20.00 g with an average value of 23.54 g). According to Drvodelić *et al.*, (2015) classification, fruits from analysed genotypes fit in the small and medium division. Šebek (2013) had values in terms of fruit weight between 8.95 g and 33.65 g while Hassan *et al.*, (2017) between 1.06 g to 81.34 g. The fruit shape index (FSI), is the ratio between fruit height and fruit diameter and represents one of the most important traits of fruit external quality (Li *et al.*, 2015). FSI for studied genotypes had a minimum value of 0.61 at Ms2 and a maximum value of 1.12 at Ms17. If taken as a population the average fruit shape index value was 0.84, which is consistent with the result obtained by Drvodelić *et al.*, (2015) with 0.86 for small fruits category, 0.84 for medium fruits category and 0.81 for large fruits category.

Table 1. Phenotypic characteristics of *Malus sylvestris* (L.) Mill. Genotypes.

Genotype	Basal stem diameter (cm)	Trunk height (cm)	GPS Coordinates	Altitude (m)
Ms1	22.28	143	44° 06'N 23°54'E	58
Ms2	17.18	48		60
Ms6	27.05	235	44°07'N 23°54'E	60
Ms8	9.86	22		60
Ms14	26.73	126		63
Ms15	19.73	294		61
Ms16	12.41	156		61
Ms17	14.64	146		60
Ms18	15.91	332		62
X ± SD	18.42 ± 6.04	166.89 ± 103.67		
Variations limits	9.86 – 27.05	22 - 332		
CV %	32.79	62.11		

X – Mean; SD – Standard deviation; CV% - Coefficient of variation

Table 2. Variability of European crab apple fruits morphological characteristics.

Genotype	Descriptive statistics	Fruit height (mm)	Fruit diameter (mm)	Fruit weight (g)	FSI*
Ms1	X ± SD	28.08 ± 2.54	35.41 ± 3.21	15.18 ± 3.58	0.79 ± 0.05
	Variations limit	20.75 – 34.26	26.95 – 43.48	8 – 26	0.66 – 1.00
	CV %	9.04	9.06	23.58	6.32
Ms2	X ± SD	23.10 ± 3.08	31.03 ± 3.69	10.60 ± 3.70	0.75 ± 0.06
	Variations limit	16.69 – 29.62	23.97 – 40.09	4 – 20	0.61 – 0.91
	CV %	13.33	11.89	34.90	8.00
Ms6	X ± SD	21.60 ± 2.06	25.09 ± 2.06	6.63 ± 1.47	0.86 ± 0.06
	Variations limit	17.58 - 27.47	20.14 – 30.31	4 – 11	0.77 – 1.02
	CV %	9.53	8.21	22.17	6.97
Ms8	X ± SD	23.25 ± 1.91	28.36 ± 2.27	8.81 ± 1.88	0.82 ± 0.04
	Variations limit	19.38 – 26.42	23.78 - 33.43	5 - 13	0.73 – 0.95
	CV %	8.21	8.00	21.33	4.87
Ms14	X ± SD	19.95 ± 1.58	24.55 ± 2.31	5.96 ± 1.58	0.81 ± 0.05
	Variations limit	16.64 – 23.79	19.47 -29.73	3 - 10	0.70 – 0.94
	CV %	7.91	9.40	26.51	6.17
Ms15	X ± SD	24.37 ± 3.14	27.15 ± 4.01	8.32 ± 3.47	0.90 ± 0.07
	Variations limit	18.43 – 29.26	20.23 – 34.74	3 – 15	0.78 – 1.07
	CV %	12.88	14.76	41.70	7.77
Ms16	X ± SD	23.36 ± 2.45	26.27 ± 2.67	7.82 ± 2.36	0.89 ± 0.05
	Variations limit	19.08 -28.16	20.42 – 30.98	4 - 13	0.80 – 1.07
	CV %	10.48	10.16	30.17	5.61
Ms17	X ± SD	27.07 ± 1.85	31.62 ± 1.56	13.12 ± 1.85	0.86 ± 0.05
	Variations limit	23.12 – 35.47	28.01 – 35.07	9 – 18	0.75 – 1.12
	CV %	6.83	4.93	14.10	5.81
Ms18	X ± SD	25.69 ± 2.46	28.66 ± 2.79	10.35 ± 2.88	0.90 ± 0.06
	Variations limit	18.9 – 33.00	20.83 – 33.94	4 - 17	0.70 - 1.08
	CV %	9.57	9.73	27.82	6.66
All genotypes	X ± SD	24.34 ± 3.56	29.09 ± 4.53	10.17 ± 4.26	0.84 ± 0.07
	Variations limit	16.64 – 35.47	19.47 – 43.48	3 - 26	0.61 – 1.12
	CV %	14.62	15.57	41.88	8.33

X – Mean; SD – Standard deviation; CV% - Coefficient of variation; FSI – Fruit Shape Index (fruit height/fruit diameter)

The CV% had values between 6.83% at Ms17 to 13.33% at Ms2 in terms of fruit height, 4.93% at Ms17 to 14.76% at Ms15 for fruit diameter, 14.10% at Ms17 to 41.70% at Ms15 for fruit weight and 4.87% at Ms8 to 8.00% at Ms2 for FSI, meaning that there is variability inside each genotype and also variability for all genotypes if taken as a population with 14.62% for fruit height, 15.57% for fruit diameter, 41.88% for fruit weight and 8.33% for FSI. The results are higher than those obtained by Šebek (2018) which had a CV% of 2.17 for fruit height, 1.91 for fruit width and 5.29 for fruit weight. Table 3 presents the percentage distribution of fruits according to studied morphological parameters, fruit height, fruit diameter and fruit weight. 32.30% of fruits, had fruit height between 20.40 mm to 24.17 mm and 2.47% of fruits between 31.70 mm to 35.47 mm. In terms of fruits diameter, 36.57% had values between 28.11 mm to 32.92 mm and 2.16% between 39.64 mm to 43.48 mm, whereas the fruit weight percentage distribution was of 32.56% for fruits between 3.00 g to

7.60 g and 1.54% between 21.40 g to 26.00 g. All fruits were green to light green to yellow colour, one of the major traits in determination of crab apple. The diameter of the fruit influences the weight of the fruit (Fig. 1), according to the correlation between the two characteristics with an R^2 of 0.9286 (y = 0.9067x - 16.199) and r=0.96; similar result obtained by Drvodelić *et al.*, (2015) with a correlation coefficient of 0.97. Based on the analysed parameters can be concluded that the fruits were mostly flat globose to globose shape with some sparse cases of conical globose fruits shape, this being in agreement with the results obtained by Reim *et al.*, (2012). The fruit load was medium to high, depending on light intensity and also age of the tree, older trees having more fruits then the younger ones which confirms Reim *et al.*, (2012) and Michalak *et al.*, (2015) statement that wild apple has high light requirements and prefers locations at the edge or in sparse forests. Light intensity is influenced by several factors such as day length, solar angle, atmospheric cover, plant density, plant height, land exposure (Dorais, 2003), meaning that a low light affects photosynthesis and thus fruit formation and fruit load. Šebek (2018) states that genotypes with very small fruits are preferable for being used as rootstocks.

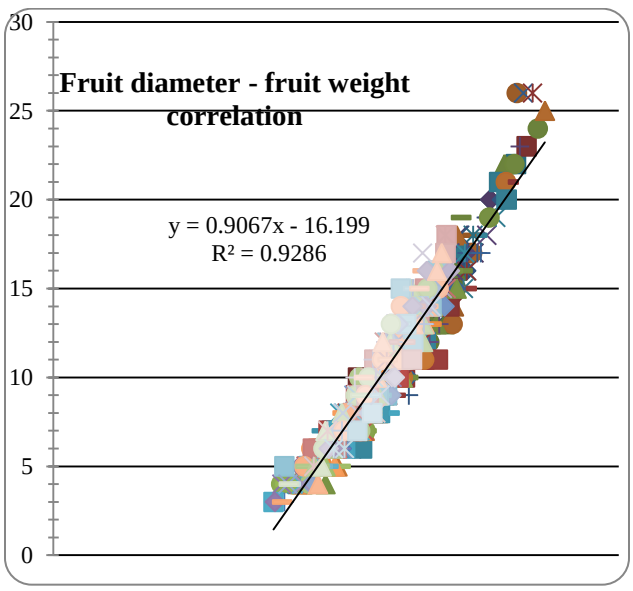

Fig. 1. Correlation between two morphological characteristics of wild apple fruits.

Leaf size and shape influences a wide variety of important physiological processes, including photosynthesis, transpiration and thermoregulation, and vary with a number of environmental factors (Yates *et al.*, 2010). In terms of leaf characteristics, the leaf laminar size was determined by measuring the leaf area surface (Table 4) and had values between 8.02 cm^2 (Ms15) to 48.48 cm^2 (Ms8). The leaf length had limits from 3.86 cm (Ms15) to 10.00 cm (Ms16) and the leaf width variation limits were between 2.67 cm (Ms15) to 6.11 cm (Ms14). Hassan *et al.*, (2017) had values in terms of leaf blade length for indigenous crab apple, from 6.26 cm to 12.06 cm and for the leaf blade width from 2.73 cm to 7.23 cm, similar with those obtained in this study. Worrell *et al.*, (2019) mentions in his study an average leaf length of 8.4 cm, with a minimum of 5.6 cm and a maximum of 11.6 cm, both petiole and blade. The coefficient of variation ranged between 9.63% at Ms2 to 21.25% at Ms15 for leaf surface area, 7.50% at Ms2 to 12.26% at Ms14 for leaf length, 6.57% at Ms2 to 12.80% at Ms6 for leaf width, whereas the CV% for leaf length/width ratio ranged between 7.43% at Ms17 to 14.87% at Ms6. Studied genotypes taken as a population, had a coefficient of variation of 29.30%, 19.39%, 15.29% and 17.61% in terms of leaf surface area, leaf length, leaf width and leaf length/width ratio (Table 4). According to Migicovsky *et al.*, (2018) leaf shape and size play a very important role in the growth and development of trees and fruits. Based on the leaf length/width ratio (Table 4) the analysed leaves from studied genotypes are elliptical-to-ovate shape according to obtained data with an average value of 1.59 and variation limits between 0.97 to 2.39, while the laminar symmetry tends to be symmetrical, to base asymmetrical in some cases. The lowest value was measured at Ms6 with 5.39:4.53 cm followed by Ms15 with 4.76:3.57 cm and the highest value at Ms16 with 8.08:4.25 cm. The percentage distribution of studied leaves morphometric parameters can be found in (Table 5). In terms of leaf surface area 33.89% of studied leaves had values between 20.46 cm^2 to 26.69 cm^2, while 1.67% had values between 39.14 cm^2 to 44.48 cm^2. 25.56% of leaves ranged between 6.69 cm to 7.63 cm and 7.22% between 3.86 cm to 4.80 cm for leaf length parameter. 35.55% of leaves had values between 3.72 cm to 4.25 cm and 2.78% between 2.67 cm to 3.19 cm for leaf width parameter. Leaves morphometric characteristics are an important factor in establishing photosynthetic influence on genotype development.

Table 3. Percentage distribution of wild apple fruits according to studied morphological parameters (fruit height, fruit diameter, fruit length).

Fruit height		Fruit diameter		Fruit weight	
Bins (mm)	**%**	**Bins (mm)**	**%**	**Bins (g)**	**%**
16.64 – 20.40	15.15	19.47 - 24.27	15.12	3.00 – 7.60	32.56
20.40 – 24.17	32.30	24.27 - 28.11	29.17	7.60 – 11.28	29.94
24.17 – 27.18	28.75	28.11 - 32.92	36.57	11.28 – 14.96	22.07
27.18 – 29.44	17.31	32.92 - 36.76	14.66	14.96 – 18.64	12.03
29.44 – 31.70	4.02	36.76 - 39.64	2.32	18.64 – 21.40	1.86
31.70 – 35.47	2.47	39.64 - 43.48	2.16	21.40 – 26.00	1.54

Table 4. Variability of European crab apple leaves characteristics obtained using ImageJ software.

Genotype	Descriptive statistics	Leaf surface area (cm^2)	Leaf length (cm)	Leaf width (cm)	Leaf length/Width ratio (cm)
Ms1	X ± SD	21.11 ± 4.27	6.82 ± 0.60	4.03 ± 0.50	1.70 ± 0.17
	Variations limit	13.86 – 31.26	5.40 – 8.25	3.04 – 5.19	1.34 – 2.10
	CV %	20.22	8.79	12.40	10.00
Ms2	X ± SD	24.07 ± 2.32	7.59 ± 0.57	4.26 ± 0.28	1.78 ± 0.13
	Variations limit	19.75 – 28.16	6.62 – 8.92	3.84 - 4.94	1.51 – 2.10
	CV %	9.63	7.50	6.57	7.30
Ms6	X ± SD	16.57 ± 2.31	5.39 ± 0.51	4.53 ± 0.58	1.21 ± 0.18
	Variations limit	12.83 – 21.97	4.39 - 6.64	3.47 – 6.11	0.97 – 1.66
	CV %	13.94	9.46	12.80	14.87
Ms8	X ± SD	31.81 ± 5.37	8.08 ± 0.67	5.19 ± 0.46	1.56 ± 0.10
	Variations limit	25.96 - 48.48	7.16 – 9.49	4.31 – 6.07	1.42 – 1.74
	CV %	16.88	8.29	8.86	6.41
Ms14	X ± SD	28.19 ± 4.25	7.50 ± 0.92	5.12 ± 0.58	1.48 ± 0.22
	Variations limit	17.95 – 38.03	6.24 – 9.68	3.75 – 6.11	1.02 – 1.88
	CV %	15.07	12.26	11.32	14.86
Ms15	X ± SD	12.80 ± 2.72	4.76 ± 0.51	3.57 ± 0.40	1.34 ± 0.10
	Variations limit	8.02 - 16.77	3.86 – 5.53	2.67 – 4.41	1.19 - 1.60
	CV %	21.25	10.71	11.20	7.46
Ms16	X ± SD	24.78 ± 4.88	8.08 ± 0.62	4.25 ± 0.48	1.92 ± 0.23
	Variations limit	19.87 – 40.47	7.24 – 10.00	3.38 – 5.51	1.57 – 2.39
	CV %	19.69	7.67	11.29	11.97
Ms17	X ± SD	19.14 ± 2.27	6.05 ± 0.55	4.10 ± 0.35	1.48 ± 0.11
	Variations limit	15.92 - 24.37	5.16 -7.20	3.42 – 4.77	1.27 - 1.63
	CV %	11.85	9.09	8.53	7.43
Ms18	X ± SD	23.62 ± 3.34	7.88 ± 0.93	4.36 ± 0.54	1.82 ± 0.22
	Variations limit	18.38 – 29.42	6.57 – 9.74	3.63 -5.62	1.44 – 2.15
	CV %	14.14	11.80	12.38	12.08
All genotypes	X ± SD	22.45 ± 6.58	6.91 ± 1.34	4.38 ± 0.67	1.59 ± 0.28
	Variations limit	8.02 – 48.48	3.86 – 10.00	2.67 – 6.11	0.97 – 2.39
	CV %	29.30	19.39	15.29	17.61

Table 5. Percentage distribution of wild apple leaves according to studied morphometric parameters (leaf surface area, leaf length, leaf width).

Leaf surface area		Leaf length		Leaf width	
Bins (cm^2)	%	Bins (cm)	%	Bins (cm)	%
8.02 – 14.24	8.89	3.86 – 4.80	7.22	2.67 – 3.19	2.78
14.24 – 20.46	31.11	4.80 – 5.74	16.67	3.19 – 3.72	10.00
20.46 – 26.69	33.89	5.74 – 6.69	17.22	3.72 – 4.25	35.55
26.69 – 32.91	20.55	6.69 – 7.63	25.56	4.25 – 4.78	27.23
32.91 – 39.14	3.89	7.63 – 8.58	25.55	4.78 – 5.31	13.33
39.14 - 48.48	1.67	8.58 - 10.00	7.78	5.31 - 6.11	11.11

Conclusions

Based on the analyzed characteristics of European crab apple fruits and leaves, the obtained data and results, the correlations between studied genotypes and to date scientific literature, *Malus sylvestris* (L.) Mill., needs to be furthered investigated due to its current status of endangered species. The morphological characteristics of wild apple fruits and leaves are important in selecting valuable genotypes for practice and improvement.

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