BIOMETRIC AND MORHOLOGIC OBSERVATIONS ON *PRUNUS ARMENIACA* L. 'MAMAIA' (ROSACEAE) LEAVES

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ABSTRACT

The paper discloses a research model of leaf investigation, based on biometrical measurements and morphological observations. There are only a few examples of this type of biometrical investigation and analysis model applied on spontaneous plants leaves in literature. The article comprises biometrical and morphologic investigations on a cultivar species Prunus armeniaca L. *'Mamaia' leaves. The measurements and observations were performed on 40 mature leaves of the studied species, including linear measurements, percentage ratio, angular measurements and the leaf surface as well. The biometric measurements were the basis of a mathematical calculation of the average values on the studied species.*

INTRODUCTION

The paper discloses a research model of leaf investigation, based on biometrical measurements and morphological observations. The biometrical measurements were performed on *Prunus armeniaca* L '.Mamaia'(fam. Rosaceae).

Prunusarmeniaca L. - apricot (syn. *Armeniaca vulgaris* Lam.) is native to North China. Some historical sources indicate that he would have been introduced into Europe by the Romans (Lu and Bartholomew, 2003). Other historical sources deemed *Prunusarmeniaca* were brought Alexander the Great in Greece (Ensminger et al., 1994). Growing apricot apparently began in the nineteenth century in sandy desert regions in Spain and Italy.There are tall trees from 5 to 8 m or even 12 m, with a spherical or oblong or flattened elongated crown, wide and thick. The bark is gray-brown with longitudinal recesses. The leaf is green, ovate, with both sides hairless. The glabrous petiole is short and has 2 nectarines at the base. The flower petals are white or pale pink rarely solitary or grouped two by 2 to 4.5 in diameter. The fruit - drupe yellow orange red shade (1.5 or 2.5 in diameter) that can be covered by bristles, enclosing a single seed (Lu and Bartholomew, 2003; Savuescu, 1957; Niculescu, 2009; Web 1).

Figure 1. Natural view of Prunusarmeniaca L. 'Mamaia'.

Prunusarmeniaca 'Mamaia' is a Romanian origin sort approved in 1975 at the Research and Development Fruit Growing (RDFG), ValulluiTraian (Constantza County).

Average force are trees, crown spherical diffuse and fruiting branches combined short and long (Fig. 1). The fruit is round to ovoid- shaped, with a medium to large size and 45-60 g weight. The exocarp is yellow- orange with much carmine red on the sunny side.The mesocarp is orange, very succulent and flavorful, adhering to the

endocarp. The fruits are suitable for both fresh consumption and for industrial processing - jam and nectar.

Many sets of terms and methods have been devised for describing leaves (e.g. Dale et al. 1971; Dickinson et al., 1987; Hickely, 1973; Melville, 1976; Roth & Dilcher, 1978). In Romanian literature there are few examples of this type of leaf investigation and analysis model applied on spontaneous plants leaves (Bercu, 2005; Bercu and Bavaru, 2007; Bercu 2013a,b), mostly of them being paleontological studies (Givulescu, 1999, Givulescu & Soltesz, 2000). Some data refers to general biometric features such as lamina venation, mentioned in lectures and manuals of Anatomy and morphology of plants or Morphology of plants (e.g. Andrei, 1997; Buia & Péterfi, 1965; Ianovici et al. 2015a,b; Niculescu, 2004).

The purpose of this paper is to highlight the features of the leaf of *Prunusarmeniaca* 'Mamaia' **and to contribute with** more information**to complete the morphological knowledge concerning this species.**

MATERIALS AND METHODS

The morphological observations and morphometric measurements were performed on 40 mature leaves of *Prunusarmeniaca* 'Mamaia', collected from Valul lui Traian Research and Development Fruit Growing, Conatanrza County in september 2015. The methods and terms for the leaves description form and venation are largely from the leaf architectural system of Mounton (1966a,b, 1976). The biometrical measurements which had been calculated are: the linear measurements: L- leaf length, l- leaf width, h- the height of the maximum width of lamina; A- the apex length, I-I'- the apex width; Lp- the petiole length, followed by the percentage ratios: L/l- the length-width ratio (the leaf finesse); A/L- the acuminate ratio, h/L- the ovality ratio; A/I-I'- the tip finesse. The angular measurements: α- the apical angle, β- the emergent angle of the secondary veins with primaries, ɣ- the emergent angle of the tertiary veins related to the primary one and finally other measurements: the number semi-sum of secondary veins pairs (Np) and the lamina surface (S).

RESULTS AND DISCUSSION

Biometrical observations. The biometrical measurements performed on *Prunusarmeniaca* 'Mamaia' 40 leaves (Table 1, 2), represented the mathematical calculation base for the values average (Tables 3 and 4):

a. Linear measurements (Fig. 2, b; Table, 3):

$$\overline{L}_{PcM} = \sum_{i=1}^{n} \frac{L_{PcM}}{n} = \frac{L_1 + ... + L_n}{n} = \frac{97 + ... + 101}{40} = 100{,}225mm$$

$$\overline{l}_{PcM} = \sum_{i=1}^{n} \frac{l_{PcM}}{n} = \frac{l_1 + ... + l_n}{n} = \frac{55 + ... + 70}{40} = 76{,}075mm$$

$$\overline{h}_{PcM} = \sum_{i=1}^{n} \frac{h_{PcM}}{n} = \frac{h_1 + ... + h_n}{n} = \frac{40 + ... + 48}{40} = 48{,}325mm$$

$$\overline{A}_{PcM} = \sum_{i=1}^{n} \frac{A_{PcM}}{n} = \frac{A_1 + ... + A_n}{n} = \frac{11 + ... + 24}{40} = 21{,}275mm$$

$$\overline{I - I'}_{PcM} = \sum_{i=1}^{n} \frac{I - I'_{PcM}}{n} = \frac{I - I'_1 + ... + I - I'_n}{n} = \frac{9 + ... + 26}{40} = 26{,}75mm$$

$$\overline{Lp}_{PcM} = \sum_{i=1}^{n} \frac{Lp_{PcM}}{n} = \frac{Lp_1 + ... + Lp_n}{n} = \frac{53 + ... + 58}{40} = 45.30mm$$

b. Percentage ratios (Table 3):

$$\overline{\frac{L}{l}}_{PcM} = \sum_{i=1}^{n} \frac{\frac{L}{l}_{PcM}}{n} = \frac{\left(\frac{L}{l}\right)_1 + \ldots\ldots\ldots\ldots + \left(\frac{L}{l}\right)_n}{n} = \frac{1.76 + \ldots\ldots\ldots\ldots + 1.44}{40} = 1.075\%$$

$$\overline{\frac{A}{L}}_{PcM} = \sum_{i=1}^{n} \frac{\frac{A}{L}_{PcM}}{n} = \frac{\left(\frac{A}{L}\right)_1 + \ldots\ldots\ldots\ldots + \left(\frac{A}{L}\right)_n}{n} = \frac{0.11 + \ldots\ldots\ldots\ldots + 0.23}{40} = 0.19\%$$

$$\overline{\frac{h}{L}}_{PcM} = \sum_{i=1}^{n} \frac{\frac{h}{L}_{PcM}}{n} = \frac{\left(\frac{h}{L}\right)_1 + \ldots\ldots\ldots\ldots + \left(\frac{h}{L}\right)_n}{n} = \frac{0.41 + \ldots\ldots\ldots\ldots + 0.74}{40} = 0.47\%$$

$$\overline{\frac{A}{I-I'}}_{PcM} = \sum_{i=1}^{n} \frac{\frac{A}{I-I'}_{PcM}}{n} = \frac{\left(\frac{A}{I-I'}\right)_1 + \ldots\ldots\ldots\ldots + \left(\frac{A}{I-I'}\right)_n}{n} = \frac{1.22 + \ldots\ldots\ldots\ldots + 0.92}{40} = 0.80\%$$

c. Angular measurements (Fig. 2, c: Table 4):

$$\overline{\sim}_{PcM} = \sum_{i=1}^{n} \frac{\sim_{PcM}}{n} = \frac{\sim_1 + \ldots\ldots\ldots\ldots + \sim_n}{n} = \frac{86 + \ldots\ldots\ldots\ldots + 65}{40} = 77^o$$

$$\overline{}_{PcM} = \sum_{i=1}^{n} \frac{_{PcM}}{n} = \frac{_1 + \ldots\ldots\ldots\ldots + _n}{n} = \frac{50 + \ldots\ldots\ldots\ldots + 55}{40} = 45^o$$

$$\overline{¥}_{PcM} = \sum_{i=1}^{n} \frac{¥_{PcM}}{n} = \frac{¥_1 + \ldots\ldots\ldots\ldots + ¥_n}{n} = \frac{106 + \ldots\ldots\ldots\ldots + 11}{40} = 108^o$$

d. Other measurements (Table 4):

$$\overline{Np}_{PcM} = \sum_{i=1}^{n} \frac{Np_{PcM}}{n} = \frac{Np_1 + \ldots\ldots\ldots\ldots + Np_n}{n} = \frac{9 + \ldots\ldots\ldots\ldots + 11}{40} = 8.80\,\text{sec}.veins$$

$$\overline{D}_{PcM} = \sum_{i=1}^{n} \frac{D_{PcM}}{n} = \frac{D_1 + \ldots\ldots\ldots\ldots + D_n}{n} = \frac{5 + \ldots\ldots\ldots\ldots + 6}{40} = 6.17 teeth/cm$$

$$\overline{S}_{PcM} = \sum_{i=1}^{n} \frac{S_{PcM}}{n} = \frac{S_1 + \ldots\ldots\ldots\ldots + S_n}{n} = \frac{35.74 + \ldots\ldots\ldots\ldots + 62.39}{40} = 51.87 cm^2$$

Size class = Mesophyll

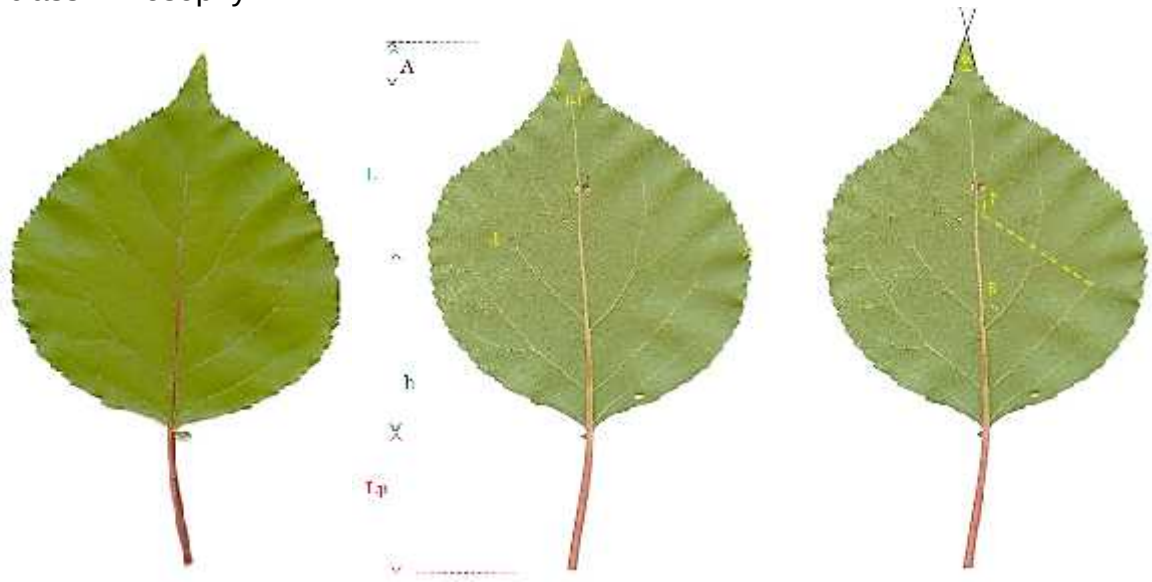

Figure 2. Prunusarmeniaca 'Mamaia' leaves. Ventral lamina surface (a). Dorsal lamina surface with liniar (b) and angular measurements (c).

Table 1

Liniar measurements on*Prunusarmeniaca* 'Mamaia' leaves

Leaf No.	L mm	l mm	h mm	A mm	l-l' mm	Lp mm	L/l %	A/L %	h/L %	A/l-l' %
1	97	55	40	11	9	53	1.76	0.11	0.41	1.22
2	92	61	40	19	20	49	1.50	0.20	0.43	0.95
3	110	79	58	21	21	48	1.39	0.19	0.52	1.00
4	91	57	47	28	28	53	1.59	0.30	0.51	1.00
5	88	85	41	20	29	39	1.03	0.22	0.46	0.68
6	133	81	59	25	22	49	1.64	0.18	0.44	1.13
7	100	99	51	15	31	40	1.01	0.15	0.51	0.48
8	90	77	46	17	25	43	1.16	0.18	0.51	0.68
9	116	75	50	25	20	43	1.54	0.21	0,43	1.25
10	95	81	46	20	29	47	1.17	0.21	0.48	0.68
11	107	84	50	19	31	50	1.27	0.17	0.46	0.61
12	105	90	50	19	19	47	1.16	0.18	0.47	0.65
13	84	56	39	19	25	50	1.50	0.22	0.46	0.76
14	108	88	54	20	31	40	1.22	0.18	0.50	0.64
15	100	72	50	20	25	50	1.38	0.20	0.50	0.80
16	99	93	49	18	33	38	1.06	0.18	0.49	0.54
17	96	73	43	20	26	45	1.31	0.20	0.44	0.76
18	90	84	45	19	30	35	1.07	0.21	0.50	0.63
19	125	91	59	40	45	51	1.37	0.32	0.47	0.88
20	100	61	45	29	23	58	1.63	0.29	0.45	1.26
21	111	80	51	17	28	45	1.38	0.15	0.45	0.60
22	99	84	49	21	29	45	1.17	0.21	0.49	0.72
23	103	80	48	20	25	45	1.28	0.19	0.46	0.80
24	97	70	48	21	28	43	1.38	0.21	0.49	0.75
25	99	76	47	19	28	46	1.30	0,19	0.47	0.67
26	100	73	58	20	25	45	1.36	0,20	0.58	0.80
27	106	80	51	20	26	47	1.32	0,18	0.48	0.76
28	97	78	46	21	29	47	1.24	0.21	0.47	0.72
29	102	79	50	21	26	44	1.29	0.20	0.49	0.80
30	101	78	50	20	27	42	1.29	0.19	0.49	0.74
31	82	54	40	18	23	48	1.51	0.21	0,48	0.78
32	124	79	51	30	29	51	1.56	0.24	0.41	1.03
33	64	45	35	18	25	39	1.42	0.28	0.54	0.72
34	120	83	59	25	29	40	1.44	0.20	0.49	0.86
35	97	80	47	20	27	40	1.21	0.20	0.48	0.74
36	100	65	44	24	25	38	1.53	0.24	0,44	0.96
37	110	73	54	29	25	40	1.50	0.26	0.49	1.16
38	93	78	46	21	26	36	1.19	0.22	0.49	0.80
39	97	96	49	18	42	45	1.01	0.18	0,50	0.42
40	101	70	48	24	26	58	1.44	0.23	0.47	0.92

Table 2

Percentage ratio, angular measurements, other measurements and the size class of *Prunusarmeniaca* 'Mamaia' leaves.

Leaf No.	α°	β°	γ°	Np	D/cm	S (cm^2)	Size class
1	86	50	106	9	5	35.74	Notophyll
2	75	44	110	8	7	37.60	Notophyll
3	88	45	100	9	6	58.22	Mesophylll
4	89	50	112	10	6	34.75	Notophyll
5	90	38	103	8	7	50.11	Mesophyll
6	81	47	95	10	5	72.17	Mesophyll
7	84	31	100	8	7	66.33	Mesophyll
8	89	33	114	9	7	46,43	Mesophyll
9	85	43	115	10	5	58.29	Mesophyll
10	90	39	109	9	5	51.55	Mesophyll
11	88	44	120	8	6	60.21	Mesophyll
12	90	43	114	10	7	63.31	Mesophyll
13	89	43	94	10	7	31.51	Notophyll
14	87	41	101	9	7	63.67	Mesophyll
15	90	42	105	10	5	48.24	Mesophyll
16	85	31	96	8	6	61.68	Mesophyll
17	85	38	100	10	7	46.95	Mesophyll
18	80	40	112	10	5	50.65	Mesophyll
19	85	40	111	9	6	76.21	Mesophyll
20	82	50	109	8	6	40.87	Mesophyll
21	70	55	115	8	5	59.49	Mesophyll
22	75	50	121	11	7	55.71	Mesophyll
23	77	48	119	9	7	55.20	Mesophyll
24	75	51	108	8	5	45.49	Mesophyll
25	75	53	100	9	6	50.41	Mesophyll
26	70	58	105	7	6	48.91	Mesophyll
27	62	50	112	10	5	58.81	Mesophyll
28	71	46	99	10	7	50.69	Mesophyll
29	75	45	115	8	5	53.98	Mesophyll
30	73	44	135	8	5	52.78	Mesophyll
31	61	38	100	9	6	29.66	Notophylll
32	65	49	100	10	6	65.63	Mesophyll
33	50	38	102	7	7	19.29	Mesophyll
34	58	48	121	8	5	66.73	Mesophyll
35	65	50	105	9	5	51.99	Mesophyll
36	66	52	107	8	6	43.55	Mesophyll
37	70	55	125	12	5	53.80	Mesophyll
38	74	44	116	9	5	48.60	Mesophyll
39	78	52	95	8	7	62.39	Mesophyll
40	65	55	111	11	6	47.36	Mesophyll

Morphological observations. Laminas are framed dominant in mesophyll size class (S = 40.87 – 76.21 cm^2), occasionally notophyll and microphyll (Table 2, 4). Mouton (1966a) registered the leaves size class values as: leptophyll (0-0.25 cm^2), nanophyll(0.25-

2.25 cm^2), microphyll (2.25 - 20.25 cm^2), notophyll (20.25 - 40 cm^2), mesophyll (40 - 182.25 cm^2), macrophyll (182-1640.2 cm^2) and megaphyll (over 1600.2 cm^2). Laminas are glabrous, green adaxially and slightly light green abaxially (Fig. 2, a-c), with a large ovate shape, (the maximum width is in the upper part of the lamina), with an ovalityreport average (h/L) 0.47%, ending in a finesse (A/I-I' = 0.80%), acuminate and sharp apex (α = 61 - 80º) (Table 1, 2). The base is cuneate with crenate serrate margin. The lamina has a coriaceous texture. The cylindrical petiole is reddish, glabrous with 15 - 28 mm length (Fig. 2, a-c; Table 1). The mid vein is right and lamina havesemicraspedodromoussecondary veins (Andrei, 1997; Buia&Péterfi, 1965; Givulescu, 1999) with a large number of secondary veins (Np = 6-7) (Fig. 2, a-c; Table 2, 4). The emergent angle between the primary and the secondary veins (β) is norrow acute to moderate for all leaves (β = 31º - 58º) (Fig. 2, a-c.; Table 2). The tertiary veins (3 order) are oblique constant towards the secondary's, forming an obtuse angle (ɣ = 94 - 135º) with the primaries (Fig. 2, a-b; Table 2, 3). Lamina size: L = 84 – 133 mm; l = 54-99 mm (Table 1).

Table 3

The average of the linear measurements and percentage ratios of *Prunusarmeniaca* 'Mamaia' leaves.

Species	Linear measurements					Percentage ratios				
	L (mm)	l (mm)	h (mm)	A (mm)	I-I' (mm)	Lp (mm)	L/l %	A/L %	h/l %	A/I-I' %
Prunus armeniaca 'Mamaia'	100.22	76.07	48.32	21.27	26.75	45.30	1.07	0.19	0.47	0.80

Table 4

The average of angular measurements and other measurements of*Prunusarmeniaca* 'Mamaia' leaves.

Species	Angular measurements			Other measurements			
	αº	βº	ɣº	Np	D/cm	S cm^2	Size calss
Prunus armeniaca 'Mamaia'	77	45	108	8.80	6.17	51.87	Mesophyll

CONCLUSION

The usefulness of this particular study is the fact that this method of investigation and the results may be used in plant taxonomy and paleontology researches concerning the effect of environmental factors as well as in the research of evolution.

Laminas are mesophyll, occasionally notophyll and microphyll. The linear measurements of *Prunusarmeniaca* 'Mamaia' laminas have high values concerning the length (L) and lower for the apex length (A). The cuneate laminas have crenate-srrate margins. *Prunuspersica* 'Mamaia' laminas are fineness (L/l) with fineness apex (A/I-I'). Laminas have semicraspedodromous secondary veins. *Prunusarmeniaca* 'Mamaia' apex (α) is large acuminate and sharp. The emergent angle between the primary and the secondary veins (β) is norrow acute to moderate whereas the tertiary veins to the primaries (ɣ) are obtuse. Lamina s have a coriaceous texture. The petiole is reddish, glabrous, cylindrical and quite long (Lp).

The morphological and morphometric features, based on the biometrical measurements such as the ovality ratio, the coriaceous texture, the venation type and the preponderant mesophyll size class (small surface area with higher leaf mass per unit area) allow *Prunuspersica* 'Mamaia' to be adaptable for the temperate zones and for the semiarid regions as well.

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