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PARAMETERS AND RELATIONSHIPS IN THE DESCRIPTION OF THE LEAF LIMB IN *ACER SACCHARINUM* L.

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ABSTRACT
The study analyzed the leaf limb of the species Acer saccharinum L.. One hundred samples of leaves from ten trees were randomly taken, and fifty leaves (variable sizes) were selected for the analysis. The dimensions of the leaves, length (L) and width at the three considered positions (w1, w2, w3) were determined by measurement. Based on the images of the leaves (1:1 ratio), the scanned leaf area (SLA) and the perimeter (Per) were determined. The measured leaf area was calculated based on the leaf parameters (L,w), MLA=f(L,w1), MLA=f(L,w2), MLA=f(L,w3), and the determined correction coefficients (Cc1=0.64, Cc2=0.52, Cc3=0.98). Ratios between dimensional parameters of the leaves (L, w1, w2, w3, Per) and scanned leaf surface (SLA) were calculated. Different levels of correlation between leaf parameters, scanned leaf surface and calculated ratios were recorded. The fit between the calculated MLA values and the SLA value was described by linear equations, under statistical safety conditions ($p<0.001$, $R^2=0.968$ in the case of MLA=f(L,w1), $R^2=0.951$ in the case of MLA=f(L, w2) and $R^2=0.949$ in the case of MLA=f(L,w3)). Linear equations described the determining relationship between calculated MLA and L, respectively polynomial equations of degree 2 described the determining relationship between calculated MLA values and w (w1, w2, w3). Based on the coefficient of variation (CV), there was high variability in the case of leaf length (CV=0.223) and low variability in the case of width w2 (CV=0.160). In the case of the perimeter (Per), the coefficient of variation had the value CV=0.177. In the case of the leaf surface, the values CV=0.383, respectively CV=0.408 in the case of MLA=f(L,w1), CV=0.364 in the case of MLA=f(L,w2) and respectively CV=0.396 in the case of MLA= f(L,w3).

KEY WORDS: *correction coefficient, foliar parameter ratio, leaf geometry, leaf area, proportional relations*

INTRODUCTION

Leaves are fundamental units of major importance in plant organogenesis (Ichihashi *et al.*, 2011). Leaves are of major importance in the relationship of plants with growth factors, with light energy and the conversion of sunlight into biochemical energy through the process of photosynthesis (Zhou *et al.*, 2021; Ye *et al.*, 2022; Roth-Nebelsick and Krause, 2023).

Tsukaya (2005) studied genetic control in the formation and development of leaves, in relation to environmental factors. The author associated certain elements of leaf formation and growth with the phenomenon of "compensation" and also considered the influence of environmental factors in adjusting leaf expansion (e.g. light, gravity). Ichihashi *et al.* (2011) used molecular markers and clonal analysis to study the spatiotemporal pattern of the mitotic differentiation activity of leaf primordia in *Arabidopsis thaliana*. The authors of the study reported that the proliferative zone in leaf primordia is marked by AN3 promoter activity (ANGUSTIFOLIA3), and leaf organogenesis (limb, petiole) is dependent on the correct spatial regulation of the proliferative zone in leaf primordia.

The variable compactness of the leaves, in terms of dimensions, shape, vein patterns, and the need to understand conceptually how to determine the shape of the leaves, led to studies on the genetic and environmental factors involved in these processes (Malinowski, 2013; Byrne, 2022). Dkhar and Pareek, 2014) communicated the fact that genetic factors are the basic factors that determine these leaf differentiation processes, in terms of leaf initiation, growth, expansion and leaf polarity, and environmental factors have an important role in adjusting the final form of the leaves.

Leaf surface is an essential parameter in relation to the photosynthetic process, but it has high importance in assessing the response of plants to growth conditions, expressed by normal environments, or stress factors (Nakanwagi *et al.*, 2018).

For various reasons, plant species have shown different interest in determining the leaf surface, especially through non-destructive but sufficiently precise methods. Thus, Nakanwagi *et al.* (2018) considered in the analysis of the *S. aethiopicum* Shum Group (SAS) germplasm, and based on a large number of plants (552 plants) and some representative leaves in the context of the study, the authors communicated relevant data regarding the determination of the leaf surface on based on the dimensions of the leaves, under statistical safety conditions ($p<0.001$; high values for the correlation coefficient and the regression coefficient, r, R^2).

Lin *et al.* (2020) studied the scaling relationship between leaf shape, leaf surface and leaf dry mass in different bamboo genotypes. Based on the analysis of an impressive number of leaf samples (over ten thousand), the authors of the study identified relationships of interdependence (scaling) between the shape of the leaves, the area of the leaves and the dry mass of the leaves, respectively the dry mass per surface unit. Although there were differences between the bamboo genotypes studied, or even within the same genotype, the authors showed that the scaling relationships were preserved. The aspects derived from the study are important in relation to understanding the relationship of plants with light energy and conversion into biochemical energy, respectively dry matter.

The size of the leaves is of considerable importance from an ecological point of view, a fact that has motivated many studies and research in estimating the size of the leaves in as many plant species as possible (Schrader *et al.*, 2021). Several databases have been established on this subject (e.g. TRY) and it is desired to develop them with new species. Knowing the high variability of oak leaves, Desmond *et al.* (2021) studied the variation of some leaf parameters in *Quercus macrocarpa* (variation of leaf shape and size), depending on the source of the leaves inside the tree, between trees and between sites (latitudinal variation). The authors of the study concluded the different, more pronounced influence of the site (latitude), compared to the arboreal, on the variation of the shape and size of the leaves. Also, through simulation, they recorded the power to detect the variation of leaf parameters between sites and trees and the number of leaves, and the communication results highlighted the importance of sampling in the study of leaf morphology, and the possibility of developing sampling strategies for leaf morphology studies.

Determining the leaf area based on leaf dimensions (length, width) and leaf shape presents advantages in different approaches, and the correction coefficient (or correction factor) associated with the leaf shape (typology) has led to an increase in the accuracy of determination (Schrader *et al.*, 2021).

Considering a variety of factors that can influence the shape and size of the leaves, Ma *et al.* (2022) analyzed the variation of some leaf parameters in relation to the size of the tree stem in the *Quercus pannosa* species. Based on a relevant number of trees (60 trees), in different growth models (from seeds, from roots), and representative samples of leaves (100 - 110 /tree), the authors found the variation of leaf size in direct relation with age trees, and the inverse variation of the dry weight of the leaf per surface unit in relation to the age of the trees. Also, the authors found that the Montgomery Equation (length, width, correction factor) in determining the leaf surface kept its validity, under the study conditions.

Motivated by the interest in the determination of the leaf surface in as many plant species as possible, expressed in the specialized literature, the present study considered the determination of the leaf surface based on the leaf parameters and the analysis of some elements of proportionality in the species *Acer saccharinum* L.

MATERIAL AND METHODS

In accordance with the purpose of the study, leaves from the *Acer saccharinum* L. species were considered for analysis.

The biological material was represented by leaf samples, collected randomly, from different areas of the crown, from ten trees. 100 leaves of variable sizes were collected, which represented the primary samples. From the primary samples, 50 whole leaves, without defects (deformations, perforations, etc.), were selected for analysis and determination, figure 1.

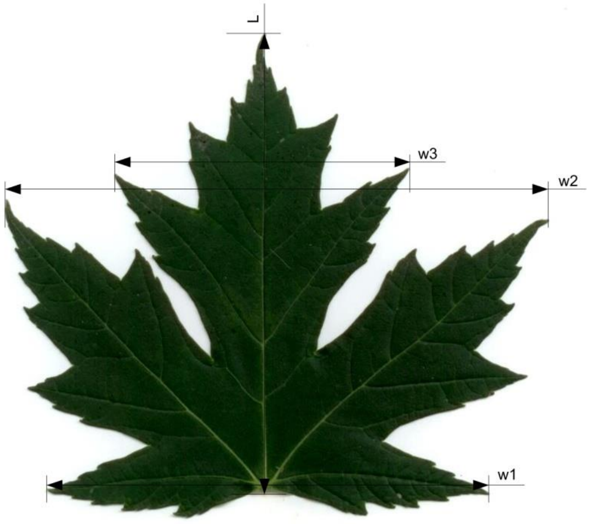


Figure 1. *Acer saccharinum* L. leaf and leaf parameters (L – leaf length; w1, w2, w3 – leaf width in three considered positions)

The dimensions of the leaves, length (L) and width at the three considered positions (w1, w2, w3) were determined by measuring with a ruler (±0.5 mm precision).

Leaves were scanned individually (1:1 ratio), and digital images (jpeg format) were analyzed to determine the scanned leaf area (SLA) and perimeter (Per) (Rasband, 1997). In order to find the measured leaf area (MLA) based on the dimensions of the leaves (L, w), three calculation options were considered, depending on the width of the leaves (w1, w2, and w3); MLA=f(L,w1), MLA=f(L,w2), MLA=f(L,w3). For calculation accuracy, three values of the correction coefficient (Cc) were determined, corresponding to each MLA calculation variant. The model proposed by Sala *et al.* (2015) was considered for finding the correction coefficients. Ratios between dimensional parameters of the leaves (L, w1, w2, w3, Per) and scanned leaf surface (SLA) were calculated.

The MLA values (the three calculation variants) were evaluated and compared to the SLA (reference value), and the calculation precision for the MLA was assessed based on the average error (AE) of the RMSE parameter. Correlation analysis was used to evaluate the interdependence between leaf parameters. Regression analysis was used to obtain relationships and safety parameters, in describing the interdependence between certain determined, measured or calculated parameters. In relation to the purpose of the study, appropriate mathematical tools were used for data processing, analysis and statistical interpretation (Hammer *et al.*, 2021; JASP, 2022).

RESULTS AND DISCUSSION

Leaf samples taken randomly from the crown of 10 trees (*Acer saccharinum* L.) were measured, individually scanned and analyzed to determine the leaf surface. The primary data regarding the dimensions of the leaves (L, w1, w2, w3), the data resulting from the imaging analysis (Per, SLA) and the resulting data regarding the leaf surface measured according to the dimensions considered (MLA according to L, w1, w2 and w3) are presented in table 1. Based on the primary dimensions (L, w1, w2, w3, Per and SLA), different ratios between the respective parameters were calculated, and the values resulting from the calculations are presented in table 2.

The length of the leaves recorded values L = 7.30 – 17.25±0.37 cm, with a coefficient of variation CV = 0.223. The width of the leaves at the level of the basal lobes (w1) recorded values w1 = 5.70 – 13.80±0.30 cm, with a coefficient of variation CV = 0.217. The width of the leaves at the level of the middle lobes of the leaves (w2) varied between w2 = 7.25 – 16.20±0.28 cm, with a coefficient of variation CV = 0.16. The width of the leaves at the level of the lobes with the upper position of the leaves (w3) recorded values of w3 = 2.80 – 8.90±0.18 cm, with a coefficient of variation CV = 0.196. The perimeter of the leaves registered values Per = 47.54 – 105.45±1.95 cm, with a coefficient of variation CV = 0.177. The scanned leaf surface (SLA), considered as reference (in the comparative analysis with MLA) recorded SLA values = 28.75 – 132.98±4.14 cm^2, with a coefficient of variation CV=0.383.

The leaf area measured in relation to L and w1 recorded values MLA f(L,w1) = 28.03 – 140.43±4.42cm^2, with a coefficient of variation CV = 0.408. The leaf area measured in relation to L and w2 recorded values MLA f(L,w2) = 29.41 – 138.15±3.97 cm^2, with a coefficient of variation CV = 0.364. The leaf surface measured in relation to L and w3 recorded values MLA f(L,w3) = 21.40 – 143.04±4.30 cm^2, with a coefficient of variation CV = 0.396. In the case of the calculated ratios, low variability was recorded in the case of the Per/w2 ratio, CV=0.075, and high variability was recorded in the case of the SLA/w2 ratio, CV=0.251.

TABLE 1. Descriptive statistics, for the values of leaf parameters, *Acer saccharinum* L.

Statistical parameters	L	w1	w2	w3	Per	SLA	MLA f(L,w1)	MLA f(L,w2)	MLA f(L,w3)
Valid	50	50	50	50	50	50	50	50	50
Missing	0	0	0	0	0	0	0	0	0
Median	11.15	10.13	12.33	6.50	77.30	74.81	73.83	72.17	72.30
Mean	11.64	9.90	12.38	6.50	77.81	77.04	76.59	77.17	76.76
Std. Error of Mean	0.37	0.30	0.28	0.18	1.95	4.17	4.42	3.97	4.30
Std. Deviation	2.593	2.148	1.983	1.276	13.783	29.496	31.254	28.063	30.405
Coefficient of variation	0.223	0.217	0.160	0.196	0.177	0.383	0.408	0.364	0.396
Minimum	7.30	5.70	7.25	2.80	47.54	28.75	28.03	29.41	21.40
Maximum	17.25	13.80	16.20	8.90	105.45	132.98	140.43	138.15	143.04
25th percentile	10.00	8.15	10.85	5.66	68.82	52.47	51.46	55.19	55.10
50th percentile	11.15	10.13	12.33	6.50	77.30	74.81	73.83	72.17	72.30
75th percentile	13.74	11.55	13.95	7.45	87.12	97.27	99.42	99.17	95.42

TABLE 2. Descriptive statistics, for the values of the calculated ratios, leaves of *Acer saccharinum* L.

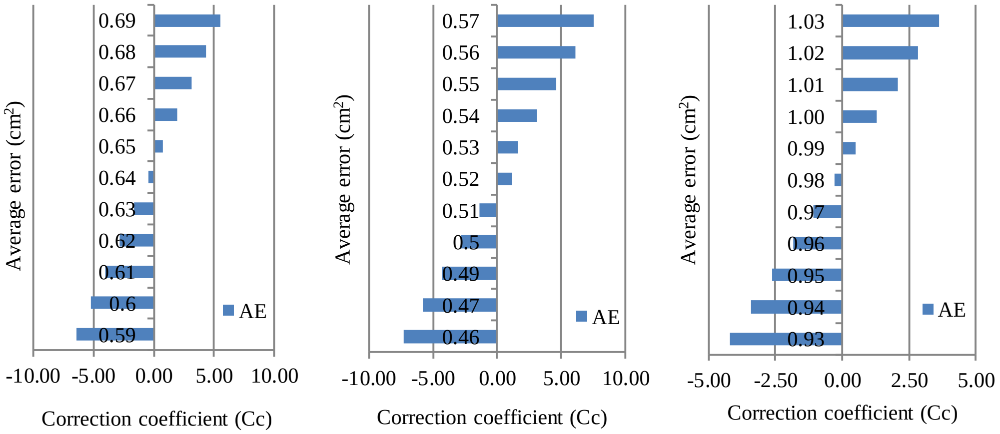
	L/w1	L/w2	L/w3	L/Per	w2/w1	w2/w3	Per/w1	Per/w2	Per/w3	SLA/L	SLA/w1	SLA/w2	SLA/w3	SLA/Per
Valid	50	50	50	50	50	50	50	50	50	50	50	50	50	50
Missing	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Median	1.16	0.90	1.77	0.15	1.24	1.90	7.77	6.23	12.06	6.57	7.40	5.76	11.44	0.96
Mean	1.19	0.94	1.80	0.15	1.28	1.93	7.97	6.29	12.09	6.41	7.56	6.03	11.51	0.96
Std. Error of Mean	0.024	0.015	0.037	0.002	0.026	0.027	0.121	0.066	0.175	0.174	0.225	0.214	0.367	0.031
Std. Deviation	0.168	0.108	0.262	0.017	0.181	0.193	0.856	0.469	1.240	1.231	1.593	1.515	2.598	0.222
Coefficient of variation	0.141	0.116	0.145	0.111	0.142	0.100	0.107	0.075	0.103	0.192	0.211	0.251	0.226	0.232
Minimum	0.90	0.74	1.35	0.12	1.00	1.60	6.73	5.34	9.41	3.69	4.42	3.37	7.05	0.60
Maximum	1.67	1.24	2.79	0.19	1.88	2.59	11.26	7.31	16.98	8.73	10.88	9.16	16.65	1.39
25th percentile	1.07	0.86	1.65	0.14	1.16	1.82	7.43	5.94	11.33	5.46	6.36	4.82	9.34	0.77
50th percentile	1.16	0.90	1.77	0.15	1.24	1.90	7.77	6.23	12.06	6.57	7.40	5.76	11.44	0.96
75th percentile	1.28	1.01	1.87	0.15	1.32	2.02	8.22	6.59	12.56	7.43	8.56	6.90	13.50	1.12

Based on the primary data (L, w1, w2, w3) and the model proposed by Sala *et al.* (2015), the values of the correction coefficients were determined in relation to each combinative (L,w), and later the MLA values were found in depending on the combinations L, w, Cc, according to the general relation MLA=L×w×Cc.

The comparative analysis of the MLA values, in relation to the SLA, and considering the average errors (AE), facilitated the finding of the optimal values for the correction coefficients (Cc). The values for the correction coefficients (Cc1, Cc2, Cc3), the measured leaf area MLA =f(L,w1), MLA =f(L,w2), MLA =f(L,w3), the minimum errors and the associated RMSE values, are presented in table 3, with the graphic distribution in figure 2.

TABLE 3. Values of the statistical parameters in relation to MLA in the leaves of *Acer saccharinum* L.

MLA =f(L,w1)				MLA f(L,w2)				MLA f(L,w3)			
Cc1	MLA	AE	RMSE	Cc2	MLA	AE	RMSE	Cc3	MLA	AE	RMSEP
0.59	70.60	-6.43	8.28091	0.47	69.75	-7.29	10.31437	0.93	72.84	-4.20	7.79211
0.60	71.80	-5.24	7.39179	0.48	71.24	-5.80	9.14621	0.94	73.62	-3.42	7.41057
0.61	73.00	-4.04	6.63591	0.49	72.72	-4.32	8.11761	0.95	74.41	-2.63	7.10856
0.62	74.19	-2.84	6.0633	0.50	74.20	-2.83	7.28793	0.96	75.19	-1.85	6.89655
0.63	75.39	-1.65	5.72917	0.51	75.69	-1.35	6.73114	0.97	75.97	-1.07	6.78296
0.64	76.59	-0.45	5.67581	0.52	77.17	1.13	6.51753	0.98	76.76	-0.28	6.77277
0.65	77.78	0.74	5.91082	0.53	78.66	1.62	6.68012	0.99	77.54	0.50	6.86642
0.66	78.98	1.94	6.40252	0.54	80.14	3.10	7.19345	1.00	78.32	1.28	7.05979
0.67	80.18	3.14	7.09776	0.55	81.62	4.59	7.99019	1.01	79.11	2.07	7.34501
0.68	81.37	4.34	7.94329	0.56	83.11	6.07	8.99536	1.02	79.89	2.85	7.71189
0.69	82.57	5.53	8.89635	0.57	84.59	7.55	10.14720	1.03	80.67	3.63	8.14941



(a) (b) (c)

FIG. 2. Distribution of the average error according to MLA; (a) MLA=f(L,w1); (b) MLA=f(L,w2); (c) MLA=f(L,w3)

The correlation analysis between the leaf size values, the scanned leaf surface, and the calculated ratios led to the values of the correlation coefficient r shown in figure 3. From the overall analysis of the recorded values, different levels of correlation were found between the leaf parameters, the calculated ratios or between these two categories of elements considered for the characterization of the leaves of *Acer saccharinum* L.

To evaluate the degree of matching of the MLA values in relation to the SLA values, regression analysis was used.

The regression analysis (linear regression) led to equations (1), (2) and (3), equations that described the fit between the SLA values (considered reference) and the MLA values obtained based on the parameter L and the three dimensions w considered (w1, w2, w3). The fit between SLA and MLA, in the case of MLA=f(L,w1) was described by equation (1), $R^2=0.968$, $p<0.001$, F=1460.3. The fit between SLA and MLA, in the case of MLA=f(L,w2), was described by equation (2), $R^2=0.951$, $p<0.001$, F=926.6. The fit between SLA and MLA, in the case of MLA=f(L,w3) was described by equation (3), $R^2=0.949$, $p<0.001$, F=901.88.

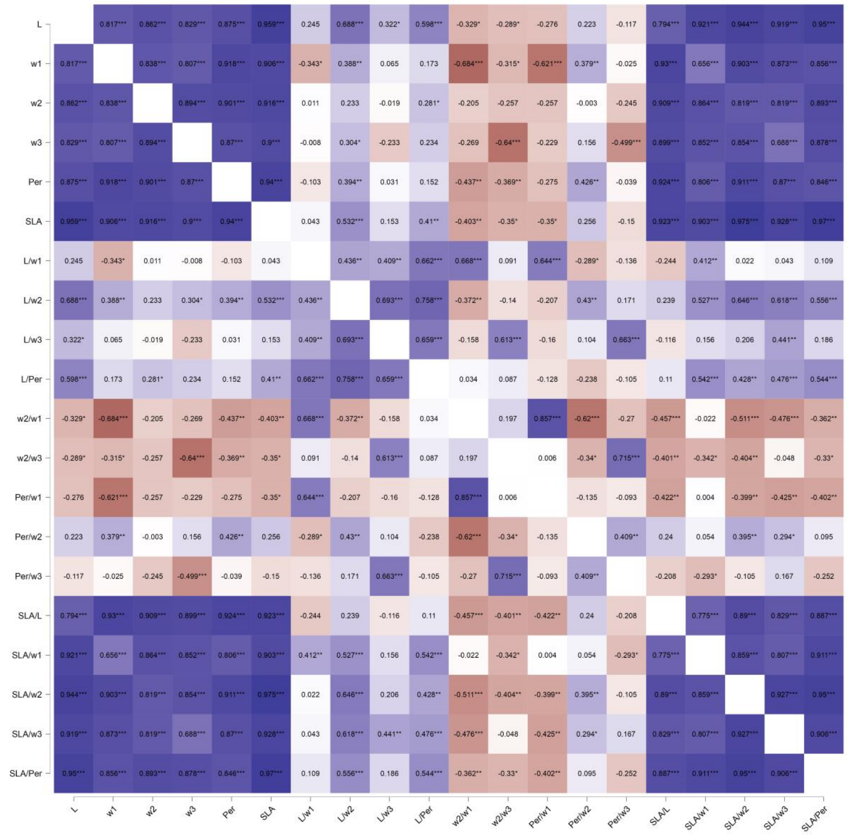
The graphic representation of the fitting lines between SLA and MLA is presented in figure 4 (a), (b), (c).

The measured leaf area (MLA) resulted based on the L and w values (w1, w2, w3) and the correction coefficients (Cc1, Cc2, Cc3), determined for each combination (L,w1; Lw2; Lw3), based on to the general relationship MLA=L×w×Cc. The determination relationship between MLA (the three determination variants) and each L and w combination was evaluated, in order to find out how tight the dependence is between the calculated MLA values and the L and w values that were the basis of the calculation. The equations resulting from the regression analysis and the values of the statistical safety parameters are presented in table 4.

Thus, in the case of MLA=f(L,w1), the relationship between MLA and L was described by equation (4), and the relationship between MLA and w1 was described by equation (5). In the case of MLA=f(L,w2), the relationship between MLA and L was described by equation (6), and the relationship between MLA and w2 was described by equation (7). In the case of MLA=f(L,w3), the relationship between MLA and L was described by equation (8), and the relationship between MLA and w3 was described by equation (9).

The determination of the leaf surface based on the dimensional parameters of the leaves (length, width) by fast, non-destructive, but sufficiently precise methods, shows more and more interest in the last period, a fact expressed in various studies

(Cândea-Crăciun *et al.*, 2018; Sala *et al.*, 2021; Schrader *et al.*, 2021; Huaccha-Castillo *et al.*, 2023; Koyama, 2023).



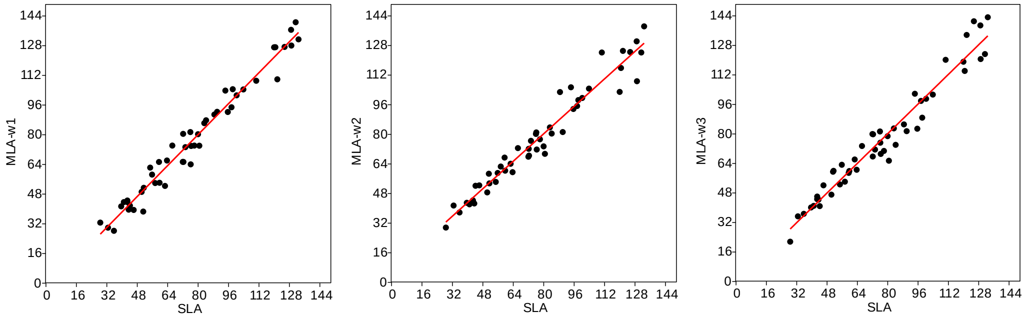
	L	w1	w2	w3	Per	SLA	L/w1	L/w2	L/w3	L/Per	w2/w1	w2/w3	Per/w1	Per/w2	Per/w3	SLA/L	SLA/w1	SLA/w2	SLA/w3	SLA/Per
L		0.817***	0.862***	0.829***	0.875***	0.959***	0.245	0.688***	0.322*	0.598***	-0.329*	-0.289*	-0.276	0.223	-0.117	0.794***	0.921***	0.944***	0.919***	0.95***
w1	0.817***		0.838***	0.807***	0.918***	0.906***	-0.343*	0.388**	0.065	0.173	-0.684***	-0.315*	-0.621***	0.379**	-0.025	0.93***	0.656***	0.903***	0.873***	0.856***
w2	0.862***	0.838***		0.894***	0.901***	0.916***	0.011	0.233	-0.019	0.281*	-0.205	-0.257	-0.257	-0.003	-0.245	0.909***	0.864***	0.819***	0.819***	0.893***
w3	0.829***	0.807***	0.894***		0.87***	0.9***	-0.008	0.304*	-0.233	0.234	-0.269	-0.64***	-0.229	0.156	-0.499***	0.899***	0.852***	0.854***	0.688***	0.878***
Per	0.875***	0.918***	0.901***	0.87***		0.94***	-0.103	0.394**	0.031	0.152	-0.437**	-0.369**	-0.275	0.426**	-0.039	0.924***	0.806***	0.911***	0.87***	0.846***
SLA	0.959***	0.906***	0.916***	0.9***	0.94***		0.043	0.532***	0.153	0.41**	-0.403**	-0.35*	-0.35*	0.256	-0.15	0.923***	0.903***	0.975***	0.928***	0.97***
L/w1	0.245	-0.343*	0.011	-0.008	-0.103	0.043		0.436**	0.409**	0.662***	0.668***	0.091	0.644***	-0.289*	-0.136	-0.244	0.412**	0.022	0.043	0.109
L/w2	0.688***	0.388**	0.233	0.304*	0.394**	0.532***	0.436**		0.693***	0.758***	-0.372**	-0.14	-0.207	0.43**	0.171	0.239	0.527***	0.646***	0.618***	0.556***
L/w3	0.322*	0.065	-0.019	-0.233	0.031	0.153	0.409**	0.693***		0.659***	-0.158	0.613***	-0.16	0.104	0.663***	-0.116	0.156	0.206	0.441**	0.186
L/Per	0.598***	0.173	0.281*	0.234	0.152	0.41**	0.662***	0.758***	0.659***		0.034	0.087	-0.128	-0.238	-0.105	0.11	0.542***	0.428**	0.476***	0.544***
w2/w1	-0.329*	-0.684***	-0.205	-0.269	-0.437**	-0.403**	0.668***	-0.372**	-0.158	0.034		0.197	0.857***	-0.62***	-0.27	-0.457***	-0.022	-0.511***	-0.476***	-0.362**
w2/w3	-0.289*	-0.315*	-0.257	-0.64***	-0.369**	-0.35*	0.091	-0.14	0.613***	0.087	0.197		0.006	-0.34*	0.715***	-0.401**	-0.342*	-0.404**	-0.048	-0.33*
Per/w1	-0.276	-0.621***	-0.257	-0.229	-0.275	-0.35*	0.644***	-0.207	-0.16	-0.128	0.857***	0.006		-0.135	-0.093	-0.422**	0.004	-0.399**	-0.425**	-0.402**
Per/w2	0.223	0.379**	-0.003	0.156	0.426**	0.256	-0.289*	0.43**	0.104	-0.238	-0.62***	-0.34*	-0.135		0.409**	0.24	0.054	0.395**	0.294*	0.095
Per/w3	-0.117	-0.025	-0.245	-0.499***	-0.039	-0.15	-0.136	0.171	0.663***	-0.105	-0.27	0.715***	-0.093	0.409**		-0.208	-0.293*	-0.105	0.167	-0.252
SLA/L	0.794***	0.93***	0.909***	0.899***	0.924***	0.923***	-0.244	0.239	-0.116	0.11	-0.457***	-0.401**	-0.422**	0.24	-0.208		0.775***	0.89***	0.829***	0.887***
SLA/w1	0.921***	0.656***	0.864***	0.852***	0.806***	0.903***	0.412**	0.527***	0.156	0.542***	-0.022	-0.342*	0.004	0.054	-0.293*	0.775***		0.859***	0.807***	0.911***
SLA/w2	0.944***	0.903***	0.819***	0.854***	0.911***	0.975***	0.022	0.646***	0.206	0.428**	-0.511***	-0.404**	-0.399**	0.395**	-0.105	0.89***	0.859***		0.927***	0.95***
SLA/w3	0.919***	0.873***	0.819***	0.688***	0.87***	0.928***	0.043	0.618***	0.441**	0.476***	-0.476***	-0.048	-0.425**	0.294*	0.167	0.829***	0.807***	0.927***		0.906***
SLA/Per	0.95***	0.856***	0.893***	0.878***	0.846***	0.97***	0.109	0.556***	0.186	0.544***	-0.362**	-0.33*	-0.402**	0.095	-0.252	0.887***	0.911***	0.95***	0.906***	

FIG. 3. Correlations between foliar parameters and calculated ratios of leaves, *Acer saccharinum* L.

$$\mathrm{MLA}_{(\mathrm{L,w1})} = 1.043 \cdot \mathrm{SLA} - 3.735 \tag{1}$$

$$\mathrm{MLA}_{(\mathrm{L,w2})} = 0.9277 \cdot \mathrm{SLA} + 5.705 \tag{2}$$

$$\mathrm{MLA}_{(\mathrm{L,w3})} = 1.004 \cdot \mathrm{SLA} - 0.6262 \tag{3}$$



(a) (b) (c)

FIG 4. The fitting rights between SLA and MLA; (a) MLA=f(L,w1); (b) MLA=f(L,w2); (c) MLA=f(L,w3), *Acer saccharinum* L. species

TABLE 4. Equations and values of the statistical parameters in the description of MLA with L and w in the *Acer saccharinum* L. species

MLA	Leaf parameter	Equation	Eq no	R^2	p	F	RMSE
$MLA_{(L,w1)}$	L	$MLA_{(L,w1)} = 11.56 \cdot L - 57.96$	(4)	0.920	<0.001	553	8.74389
	w1	$MLA_{(L,w1)} = 0.9813 \cdot w1^2 - 5.386 \cdot w + 29.28$	(5)	0.899	<0.001	209.6	9.82390
$MLA_{(L,w2)}$	L	$MLA_{(L,w2)} = 10.6 \cdot w2 - 46.14$	(6)	0.958	<0.001	1111	5.65345
	w2	$MLA_{(L,w2)} = 1.058 \cdot w2^2 - 12.45 \cdot w2 + 65.05$	(7)	0.907	<0.001	229.76	8.46234
$MLA_{(L,w3)}$	L	$MLA_{(L,w3)} = 11.32 \cdot w3 - 54.92$	(8)	0.931	<0.001	649.53	7.89591
	w3	$MLA_{(L,w3)} = 2.395 \cdot w3^2 - 8.209 \cdot w3 + 25.1$	(9)	0.906	<0.001	227.13	9.21675

The correction factor in the calculation of the leaf surface based on the dimensions of the leaves showed high importance for the calculation precision. Different values were communicated for the correction factor, in accordance with the leaf typology of the studied plant species.

Agapie *et al.* (2020), in a study on three soybean genotypes, found values of the correction factor CF=0.31 for the Caro and Onix varieties, respectively CF=0.32 for the Felix variety, in safe conditions high statistics of the leaf surface measured MLA) compared to the scanned leaf surface (SLA), p<0.001.

Based on a large study (dataset, 3125 frues, 780 taxa), Schrader *et al.* (2021) reported values of the correction factor between 0.39 - 0.79 depending on the shape of the leaves (small values for very dissected, lobed forms; high values for oblate forms) and high precision in determining the leaf surface based on the length and width of the leaves. Agapie and Sala (2023) reported values of the correction factor in the study of the leaf surface in four varieties of wheat (CF=0.78 for Glosa cultivar; CF=0.79 for Ciprian and Padureni cultivars; CF=0.80 for Dacic cultivar). The authors of the study also highlighted the variability of some foliar parameters in the four varieties of wheat, under the study conditions.

Stef *et al.* (2023), in a study on the geometry of the leaves of *Asclepias syriaca* L., reported a value of 0.74 for the correction factor (CF=0.74) in determining the leaf surface based on the size of the leaves under conditions of statistical safety ($p<0.001$).

Numerous other studies have addressed the leaf surface of plants, both plants of economic interest and plants from the spontaneous flora, and have developed models for rapid determination of the leaf surface, with practical importance in application.

The present study brings to the attention of the scientific community the values of the foliar parameters of the species *Acer saccharinum* L., and thus contributes to the development of the database associated with this subject of interest.

CONCLUSIONS

The geometry of the leaves of the species *Acer saccharinum* L. was described based on the leaf parameters (L, w1, w2, w3), the scanned leaf area (SLA), the perimeter (Per) and the calculated ratios, under statistical safety conditions.

The measured leaf area (MLA) was determined in relation to the dimensions of the leaves, and the values of the correction coefficients determined, afferent to the combination of the basic parameters L and w, respectively MLA=f(L,w1), MLA=f(L,w2), MLA=f(L,w3). The optimal values of the found correction coefficients were Cc1=0.64, Cc2=0.52, respectively Cc3=0.98.

The fit between the calculated MLA values and the scanned SLA values was described by linear equations ($p<0.001$), the best fit being recorded in the case of MLA=f(L,w1), $R^2=0.968$.

Linear and polynomial equations described the determination relationship between the MLA values in the determination conditions, and leaf parameters considered in the analysis.

Various levels of correlations were recorded between the leaf parameters considered in the study, for the analysis and characterization of the leaves of the species *Acer saccharinum* L.

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