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GRA.LE.D.

GRApevine LEaf Digitalization

Version: 2.04

User Manual



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What is GRA.LE.D?

GRA.LE.D. (GRApevine Leaf Digitalization) is free raster graphic software created for digital analysis of *Vitis* leaves based on:

- the standard ampelographic measurements suggested by the OIV (International Organization of Vine and Wine: 2nd Edition of the OIV descriptor list for grape varieties and *Vitis* species)
- non-OIV descriptors
- landmark coordinates.

During morphological description of grapevine cultivars have discovered that leaf provides numerous data which could be statistically analyzed. For facilitating objective description, we created a free software which we think may help in this process.

We appreciate your feedback, any suggestions or ideas are welcome, and please feel free to send us your questions about the GRA.LE.D software.

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This program is freely distributed AS IS in the hope that it will be useful, but WITHOUT ANY WARRANTY; without even the implied warranty of MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.

Citing GRA.LE.D.

Please refer to this software in your publication as:

Bodor P.; Baranyai L.; Parrag V.; Bisztray Gy.D. (2014): Effect of row orientation and elevation on leaf morphology of grapevine (*Vitis vinifera* L.) c.v. Furmint. *Progress in Agricultural Engineering Sciences* 10: 1. 53–69.

Bodor P.; Baranyai L.; Bálo B.; Tóth E.; Strever A.; Hunter J.J.; Bisztray Gy.D. (2012): GRA.LE.D. (GRApevine LEaf Digitalization) software for the detection and graphic reconstruction of ampelometric differences between *Vitis* leaves. *South African Journal of Enology and Viticulture* 33: 1. 1–6.

How to install?

Download the zip compressed package and save it on your hard disc or flash drive, then extract and open GRA.LE.D. executable.

How to use GRA.LE.D.?

Sampling and digitalization: collect your leaf sample and scan it even with an ordinary desktop scanner on **300 dpi** (recommended value). Save images using **bitmap** (BMP) or **JPEG** (JPG) format. Position your samples consequently with the upper side up or down. Such uniform set of images is easy to handle for any purpose. It is recommended to place your sample in the scanner with petiole up. Processing method is not sensitive to rotation or other adjustment variations, but uniformity makes batch processing much easier.

Please note that precise measurements could be carried out with some criteria:

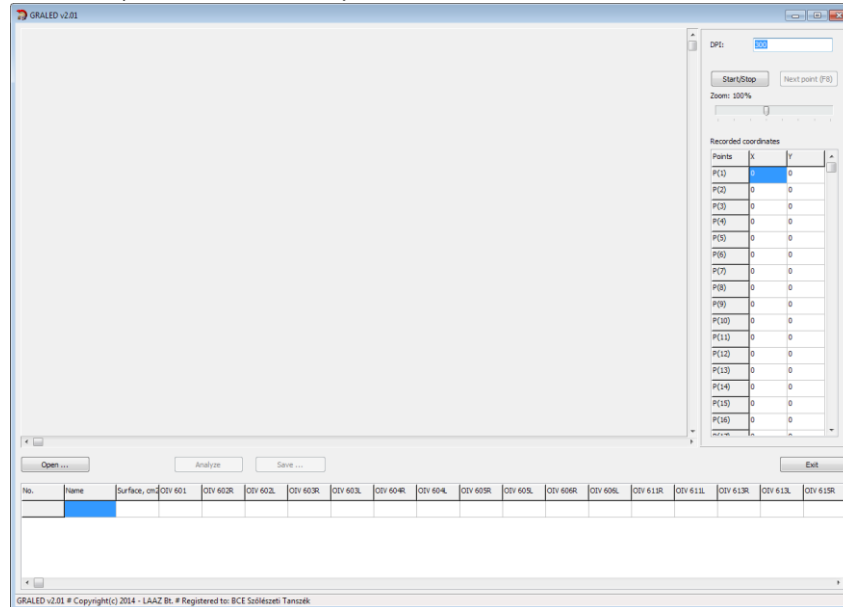
- leaf must be intact without any damage,
- flat the leaf as much as it is possible,
- mark overlapping*

* Overlapping modify your results in two ways: give false result of the leaf area and make difficulties when you measure opening of the petiole sinus. See chapter: [OVERLAPPING](#)

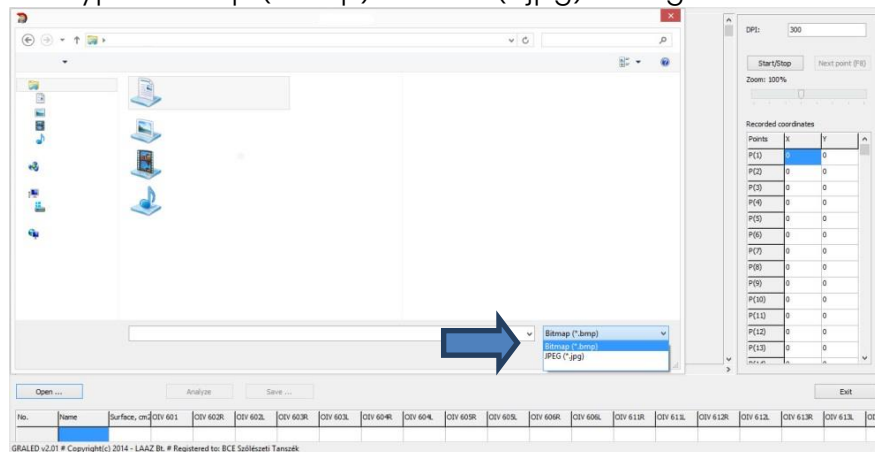
Measurement:

Before start check the [supplementary figure](#) to follow biometric points in the GRA.LE.D.

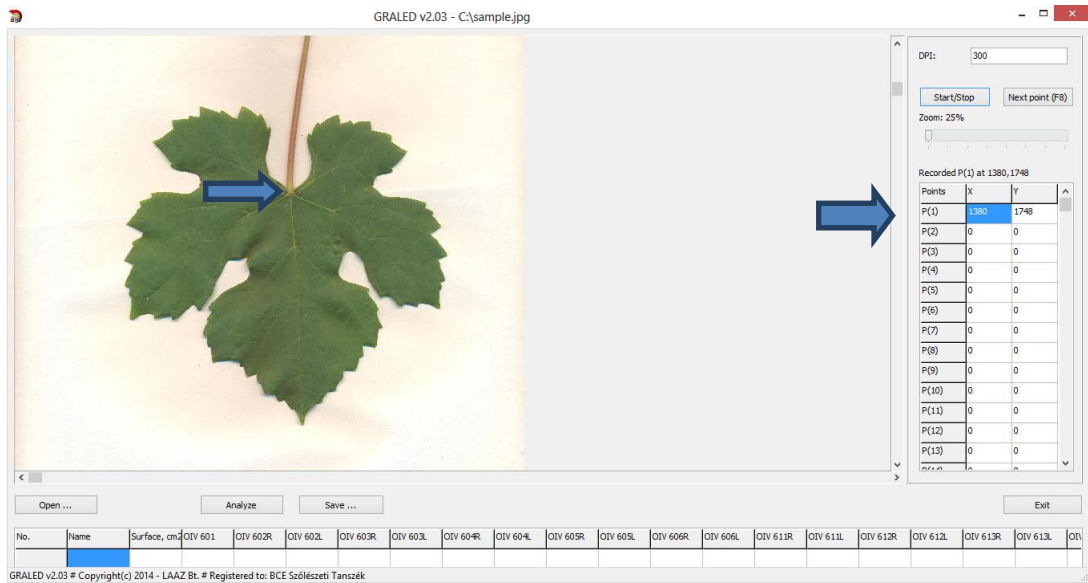
- 1 Start GRA.LE.D. and open a file from your hard disc or flash drive with "OPEN".



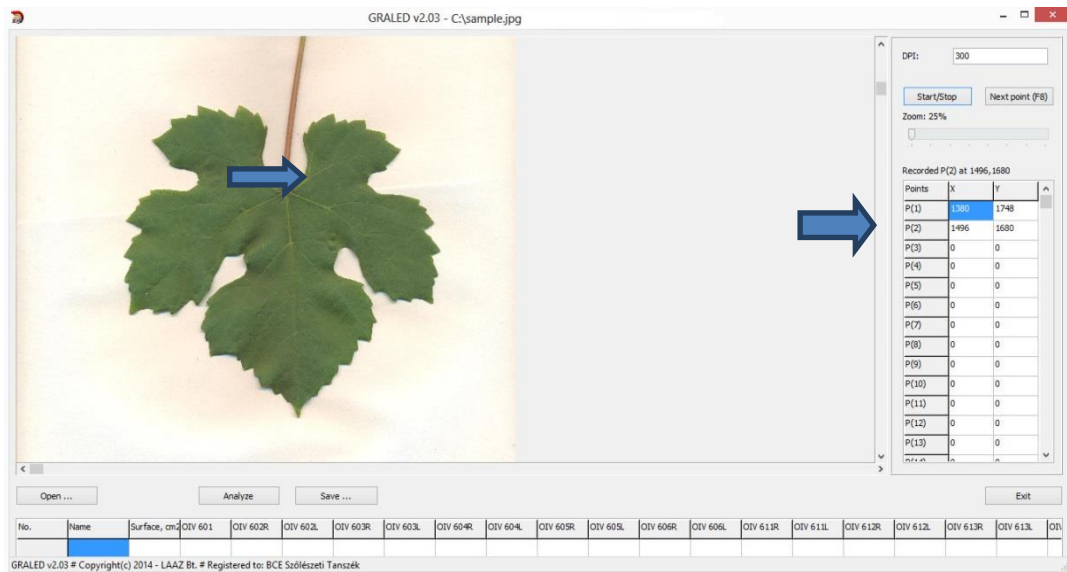
- 2 Click on "OPEN" and choose your file from your hard disc or flash drive with the selection of file type: Bitmap (*.bmp) or JPEG (*.jpg). and give DPI value



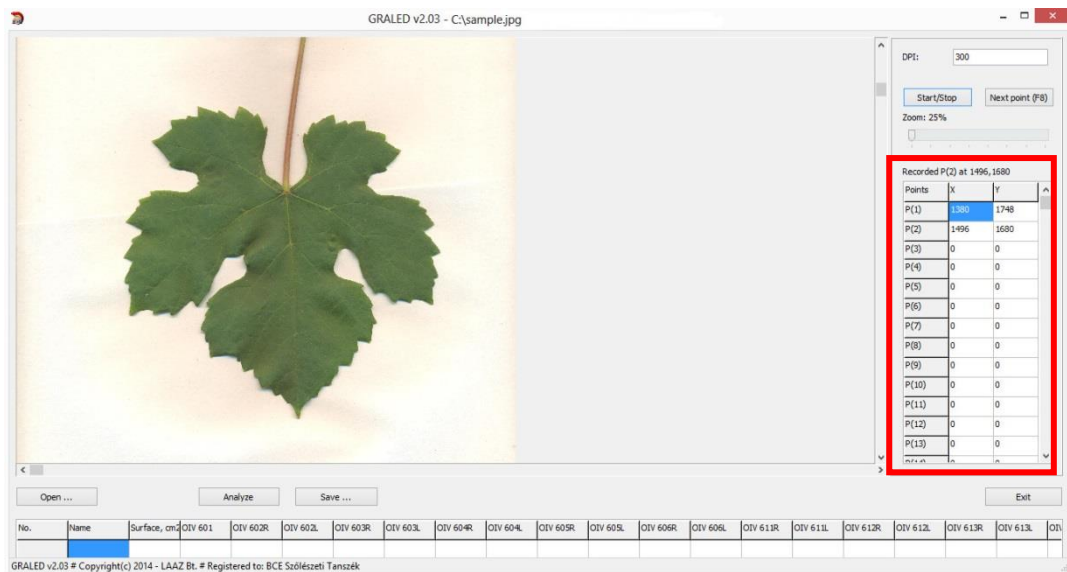
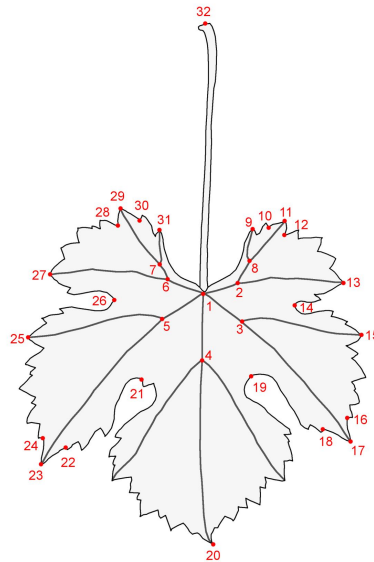
3. Zoom out and adjust zoom for proper marking of the points
4. Press "START/STOP" 2 times
5. Start selecting the 1. biometric point with click on the 1. landmark point on your sample.
Coordinates of the point appear in the right table.



6. Red cross also appear on the picture so that you can check position. In case of false positioning, click again on the correct landmark point. Coordinates will be updated automatically.
7. Press F8 for next and click to 2. landmark point. On the top of the table on the left you can check which point you are currently reading.



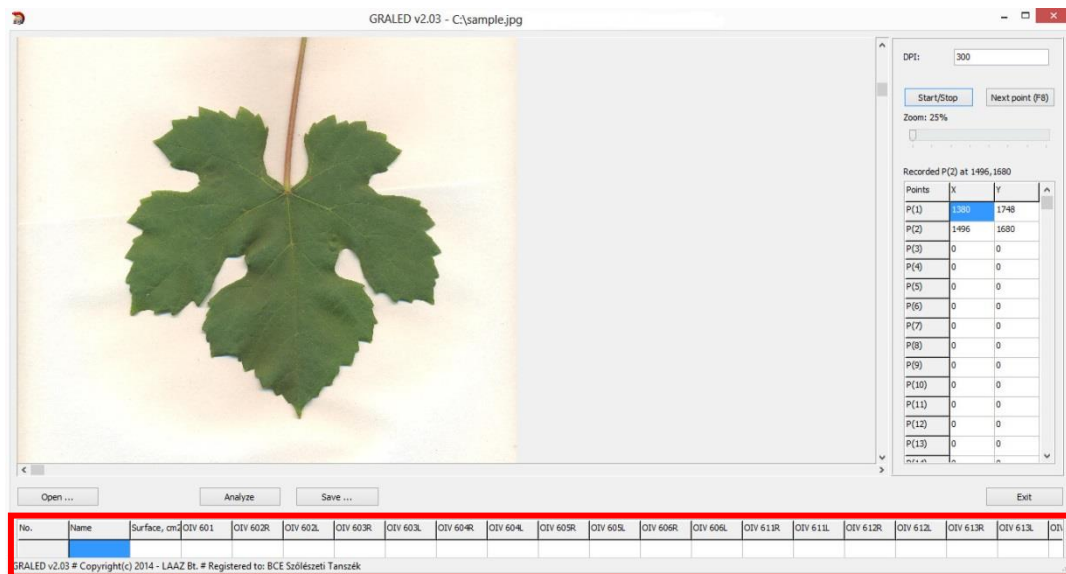
8. Go on until you finish with the 32 landmark points and Table fill with coordinates. (Figure 5)



9. When all points are defined press "ANALYZE"



10. Data appear in the lower table.



11. You have the possibility to measure further samples with opening a new image or stop measurements after a single sample.

12. Click "SAVE..." to export table data.

GRALED v2.03 - C:\sample.jpg



DPI: 300

Start/Stop Next point (F8)

Zoom: 25%

Recorded P(2) at 1496, 1680

Points	x	y
P(1)	1380	1748
P(2)	1496	1680
P(3)	0	0
P(4)	0	0
P(5)	0	0
P(6)	0	0
P(7)	0	0
P(8)	0	0
P(9)	0	0
P(10)	0	0
P(11)	0	0
P(12)	0	0
P(13)	0	0

Open ... Analyze **Save ...** Exit

No.	Name	Surface, cm ²	DIV 60L	DIV 60R	DIV 60L	DIV 60R	DIV 60L	DIV 60R	DIV 60L	DIV 60R	DIV 60L	DIV 60R	DIV 60L	DIV 60R	DIV 60L	DIV 60R	DIV 60L	DIV 60R

GRALED v2.03 # Copyright(c) 2014 - LAAZ Bt. # Registered to: BCE Szőlészeti Tanszék

Landmark points

Landmark point	Leaf characteristic
1	insertion point of leaf petiole and lamina
2	first ramification of N_3
3	first ramification of N_2
4	first ramification of N_1
5	first ramification of N_2
6	first ramification of N_3
7	first ramification of N_4
8	first ramification of N_4
9	top of the teeth N_5
10	base of the teeth N_4
11	top of the teeth N_4
12	base of the teeth N_4
13	top of the teeth N_3
14	base of the sinus
15	top of the teeth of the first ramification N_2
16	base of the teeth N_2
17	top of the teeth N_2
18	base of the teeth N_2
19	base of the sinus
20	top of the teeth N_1
21	base of the sinus
22	base of the teeth N_2
23	top of the teeth N_2
24	base of the teeth N_2
25	top of the teeth of the first ramification N_2
26	base of the sinus
27	top of the teeth N_3
28	base of the teeth N_4
29	top of the teeth N_4
30	base of the teeth N_4
31	top of the teeth N_5
32	base of the petiole

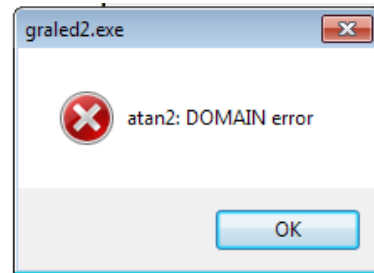
Export data:

You can export your data in tab delimited plain text (TXT) file format to your hard disc. This structured data can be imported to spreadsheet applications and statistical software. In the text file, sample name will be the same as the picture filename was.

Troubleshooting

1. Following dialog bar appear (Figure 9)

You did not select one or more biometric point of the leaf.



2. Your exported txt. file is empty

Figure 9

You forgot to press "ANALYZE" after the measurements.

3. During the data analysis you have outliers

Your sample set was not uniform, or you made mistake during the measurements.

4. After finish with the marking of 32 points you still have empty cell in the table

You forgot to press F8 in one or more times during the measurements and coordinates are overwritten. If you miss one point or marked a wrong position, correct the mistake by pressing F8 until you reach the point needs to be replaced.

5. You have "missing" landmark point on your sample

You should aim to collect intact samples without any damages, but it not always come true. It is usually happens that one or more parts are missing on the sample caused by hail, senescence of the leaves or even canopy management. When you reach to missing point simply presses F8 and skip it. Later you have to handle missing data in statistical analysis. In the present example (Figure 10) landmark point 13 is missing. In this case you reach and record landmark point 12 and press F8 two-times and indicate landmark point 14. In your exported data all missing coordinates and missing OIV values will be indicated with "N.A."

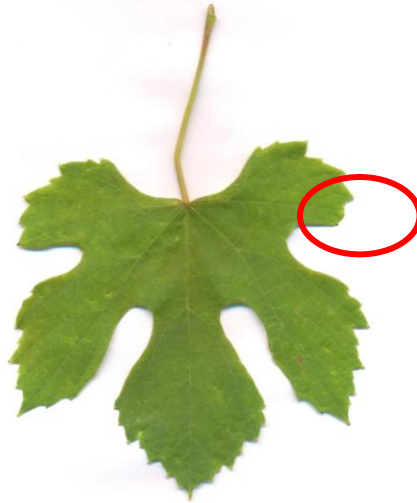
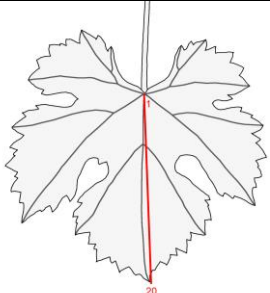
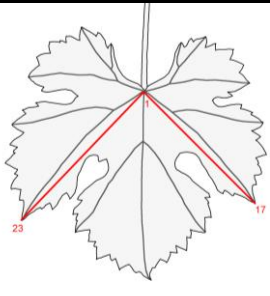
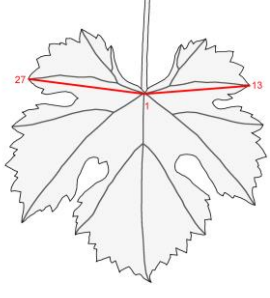
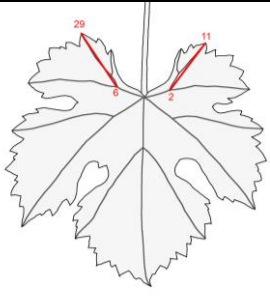
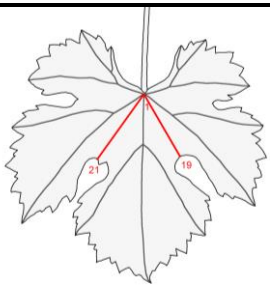


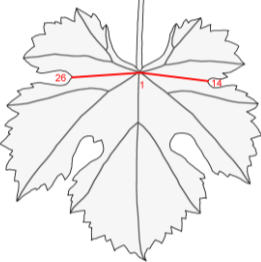
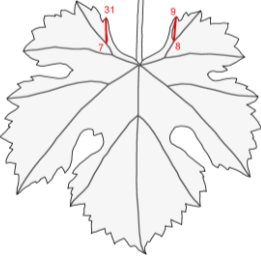
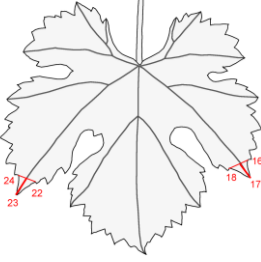
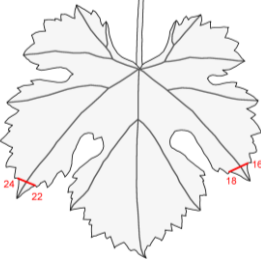
Figure 10

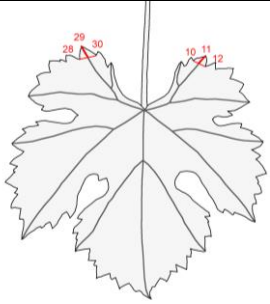
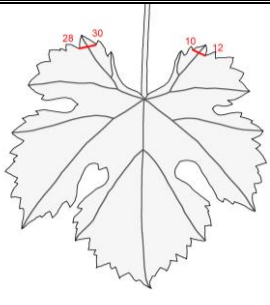
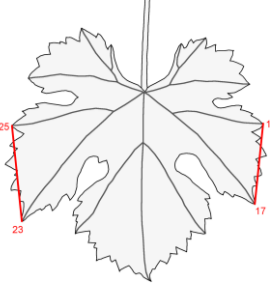
Ampelometric data provided by the software

There are 3 types of data provided by the GRA.LE.D.

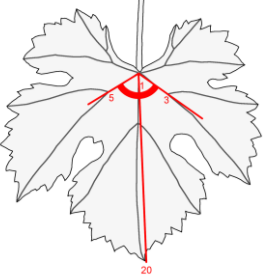
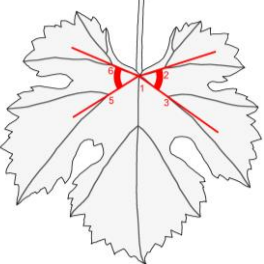
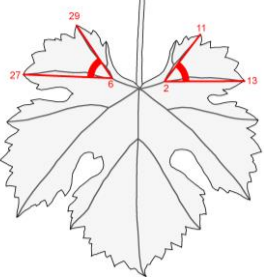
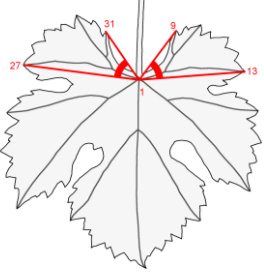
- Traits suggested by the OIV (2009) descriptor list: these traits are symmetric in some cases (e.g.: OIV 602), in these cases both left (OIV602L) and right (OIV602R) data are given. Please note that angular traits (OIV607-609) and opening of the petiole sinus (OIV618) are measured with minor differences compared to the official OIV (2009) descriptor list.
- Non-OIV descriptors: these traits are not listed in the OIV (2009) descriptor list even so these can be useful for sample comparison. With the help of the below mentioned landmark coordinated and coordinate geometry of those position further linear and angular traits can be measured.
- Landmark coordinates: GRA.LE.D. provides the landmark coordinates of the 32 biometric points. The origin (0,0) of the Cartesian coordinate is petiole junction point (landmark 1). The position of each point is given as x and y. Landmark point 2 is given as P(2).X and P(2).Y, landmark point 3 as P(3).X and P(3).Y etc. For further geometric morphometric evaluation landmark 1 have to be given manually where the position of P(1).X and P(1).Y is 0 and 0.

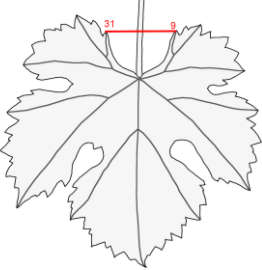
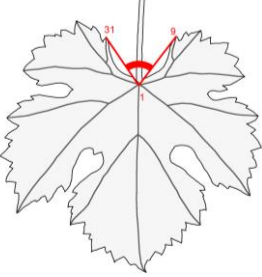
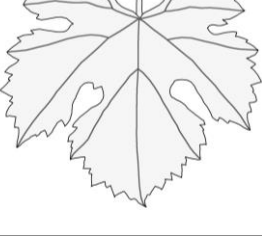
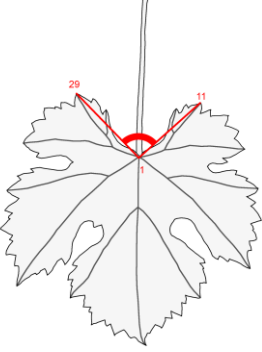
OIV601	
Length of vein N ₁	
Unit: mm	1-20
OIV602L, OIV602R	
Length of vein N ₂	
Unit: mm	1-17; 1-23
OIV603L, OIV603R	
Length of vein N ₃	
Unit: mm	1-13; 1-27
OIV604L, OIV604R	
Length of vein N ₄	
Unit: mm	2-11; 6-29
OIV605L, OIV605R	
Length of petiole sinus to upper lateral leaf sinus	

Unit: mm	1-19; 1-21
OIV606L, OIV606R	
Length of petiole sinus to lower lateral leaf sinus	
Unit: mm	1-14; 1-26
OIV611L, OIV612R	
Length of vein N5	
Unit: mm	8-9, 7-31
OIV612L, OIV612R	
Length of tooth N2	
Unit: mm	
OIV613L, OIV613R	
Width of tooth N2	
Unit: mm	16-18; 22-24

OIV614L, OIV614R	
Mature leaf: length of tooth N4	
Unit: mm	
OIV615L, OIV615R	
Width of tooth N4	
Unit: mm	10-12; 28-30
OIV617L, OIV617R	
Length between the tooth tip of N2 and the tooth tip of the first secondary vein of N2	
Unit: mm	15-17; 23-25

The following characteristics are referring to certain OIV descriptors with minor differences.

<p style="text-align: center;">OIV607L, OIV607R*</p>	
<p>Angle between the tip of N₁ and the tangent between petiole point and the first branch of the N₂.</p>	
<p>Unit: degree °</p>	<p>1-3 θ 1-20; 1-5 θ 1-20</p>
<p style="text-align: center;">OIV608L, OIV608R*</p>	
<p>Angle between N₂ and N₃ measured on the tangents formed before these veins first branch.</p>	
<p>Unit: degree °</p>	<p>1-2 θ 1-3; 1-5 θ 1-6</p>
<p style="text-align: center;">OIV609L, OIV609R*</p>	
<p>Angle between the tooth tip of N₃ and the tangent between the first branch of N₃ and the tooth tip of N₄.</p>	
<p>Unit: degree °</p>	<p>2-11 θ 2-13; 6-27 θ 6-29</p>
<p style="text-align: center;">OIV610L, OIV610R*</p>	
<p>Angle between the tooth tip of N₃ and the tangent between petiole point and the tooth tip of N₅.</p>	
<p>Unit: degree °</p>	<p>1-9 θ 1-13; 1-27 θ 1-31</p>

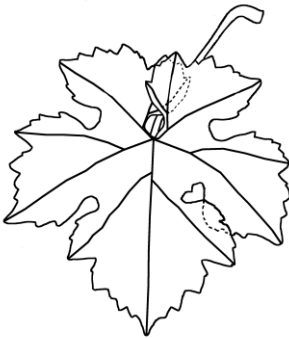
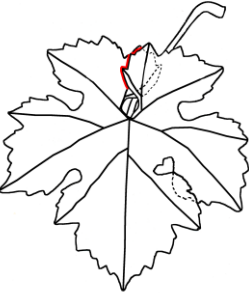
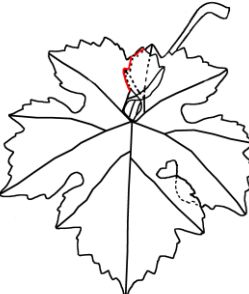
OIV618L*	
Distance between the tooth tips of N ₅ .	
Unit: mm	9-31
OIV618aR*	
Angle between the tooth tip of N ₅ and the tangent between petiole point and the tooth tip of N ₅ .	
Unit: degree °	1-9 θ 1-31
OIV618R*	
Distance between the tooth tips of N ₄ .	
Unit: mm	11-29
OIV618aL*	
Angle between the tooth tip of N ₄ and the tangent between petiole point and the tooth tip of N ₄ .	
Unit: degree °	1-29 θ 1-11

NON OIV descriptors provided by the software

Distances between the points (unit: mm)	
1-2	
1-3	
1-4	
1-5	
1-6	
1-31	
1-9	
1-29	
1-11	
1-32	
27-13	
25-15	
23-17	
11-13	
13-17	
17-20	
20-23	
23-27	
27-29	

Overlapping

To handle overlapping you should make a marking on the leaf before scanning as the following schedule suggest.

1.	Flat the leaf with overlapping on the petiole sinus.	 A line drawing of a leaf with several lobes. The lobes are arranged in a fan shape, with the top lobes overlapping the bottom lobes. A dashed line indicates the petiole sinus at the top.
2.	Mark the overlapping with color marker.	 A line drawing of a leaf with several lobes, similar to the first diagram. A red line is drawn across the overlapping area at the top, indicating where to mark the leaf.
3.	Replace the overlapped lobes.	 A line drawing of a leaf with several lobes, similar to the second diagram. A red line is drawn across the overlapping area at the top, indicating where to mark the leaf.
4.	Scan the leaf.	

Supplementary figure

