INTRODUCTION OF FRACTAL ANALYSIS IN AMPELOGRAPHY

INTRODUCEREA ANALIZEI FRACTALE ÎN AMPELOGRAFIE

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Abstract. *In this work the authours present the fractal analysis in order to characterize the structure/architecture of the leaves from the table grapevine varieties and from wine grapevine varieties. The determination of the fractal dimension of the leave contour and of the degree of section can differentiate this varieties. The fractal analysis permets us the application of the fractal geometry in the leave ampelometry domain, the leave being the specific morphologic organ of the vitaceae used in characterisation of the varieties. This method can be added to the classical method used in amplographye and it broach the subject of the usefulness of informatic resourceless in this science.*

Rezumat. *Autorii prezintă metoda de analiză fractală pentru caracterizarea structurii/arhitecturii frunzelor la unele soiuri de viță de vie pentru struguri de masă şi pentru struguri de vin. Determinarea dimensiunii fractale a formei frunzelor şi a gradului de sectare a limbului permit astfel diferențierea soiurilor. Metoda de analiză fractală permite aplicarea geometriei fractale în ameplometria frunzei la vița de vie, care este organul morfologic al vitaceelor pentru caracterizarea soiurilor. Ea completează metodele clasice folosite în ampelografie şi deschide calea aplicării mijloacelor informaționale în această stiință.*

Key words: fractal dimension, grapevine leaves, Box-Counting Method, HarFA soft, ampelography

INTRODUCTION

The term “fractal” was coined by Benoît Mandelbrot in 1975 in his book „The Fractal Geometry of Nature” and was derived from the Latin “fractus” meaning "broken" or "fractured." In order to characterize an irregular natural structure. A fractal has two important characteristics: self-similarity and fractal dimension. Selfsimilarity, this interesting property that results from fractal’ definition, means that part of fractal seems with whole fractal (the fractal apperas identical at different scales). The fractal dimension, a quantitative property, is a fractional quantity and it is a direct measure of the relativ complexity. The fractal dimension is greater than its topological dimension (5),(11).

“God does not play dice,” said Einstein. Neither a plant nor an animal can growth accidentally. Plant development and growth are markedly influenced by morphology and architecture of the plant and its parts.

Morphological characterization of grapevine leaves uses two methods: ampelometric method based on the characters and quantitative measurements of anatomical elements of the leaf, i.e. angles, area, teeth number, petiole length, and ampelographic descriptor method with their codification standardized by OIV-IBPGR-UPOV charts 1983 (10). Although grapevine leaves lack the self-similarity of the theoretical fractals, leaves are candidates for characterization using fractal analysis because of their highly complex structure. The grapevine leaves have irregular shapes and structure and it is thus it is possible to employ the fractal analysis to characterize them (4). Fractal dimension calculated for one species leaves grown in very different environments did not show any statistically significant modification revealing that fractal dimension could be considered environment-independent (3).

The fractal analysis has been used to study the plant leaves for different species of trees (1), (2), (9). A means of quantification of plant root branching, specifically under stress, is of importance for evaluating the contribution of plant roots to water and nutrient uptake and subsequently plant growth. (6), (7).

MATERIAL AND METHODS

Fractals in nature are very irregular and they have statistical self-similarity. Many methods to determine the fractal dimension and to characterize these fractals have been reported.

The fractal diemnsion (Hausdorf-Bezicovith dimension) is given by (http://paginas.fe.up.pt/~jmsa/Fractal%20Modeling%20-2001.pdf):

$$D = \frac{\log N}{\log(L/l)}$$

One of the most common methods for calculating the fractal dimension of a self-similar fractal is the Box Counting Method. To determine the fractal diemnsion need to cover a structure with boxes of length l and to count the number N which cover it (Fig.1).

The fractal dimension D is obtained as a slope of the straight line log N = f (log l) (11),(12)

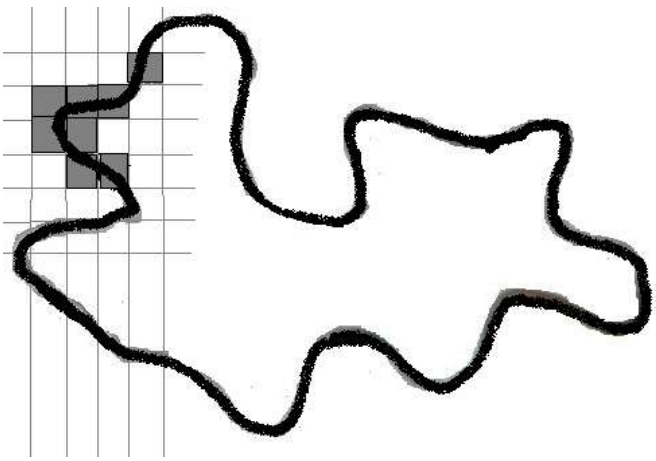

Fig.1 –Box - Counting Method for fractal dimension

In this work, HarFA soft has been used. It is an analyzer of fractal images from Institute of Physical and Applied Chemistry, Brno University of Technology, Cehia. In HarFA is used a modification of traditional Box Counting method. By this modification on obtain three fractal dimensions, which characterise properties of black plane DB, black-white border of black object DBW (and this information is the most interesting) and properties of white background DW. The fractal dimension is the slope of the straight line „Black&White" (14).

To explore HarFA soft the images need to be prepared as in figure 2.

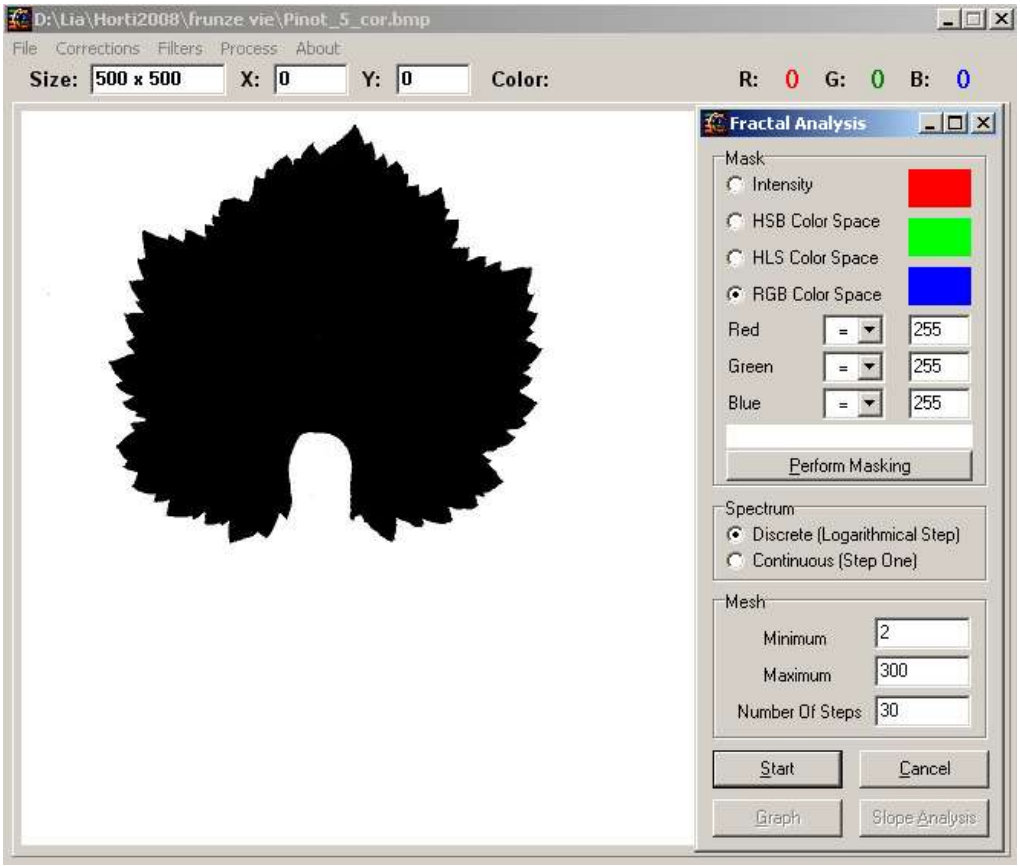

Fig.2 – Harfa Screen with Pinot noir leave

In this work, the fractal analysis has been used to study the grape vine leaves from 10 varieties: 5 for table grapevine (Muscat de Hamburg, Muscat de Adda, Napoca, Bicane and Ceaus) and 5 for wine (Berbecel, Feteasca neagra, Tamaioasa romaneasca, Merlot and Pinot noir).

5 samples for every studied varieties have been collected from the grapevine collection of the Faculty of Horticulture of the University of Agricultural Sciences and Veterinary Medicine from Iasi.

RESULTS AND DISCUSSIONS

In Figures 2 and 3 the fractal dimension for Pinot noir and Muscat Hamburg are given.

We have presented our results of fractal dimension in table 1 and table 2

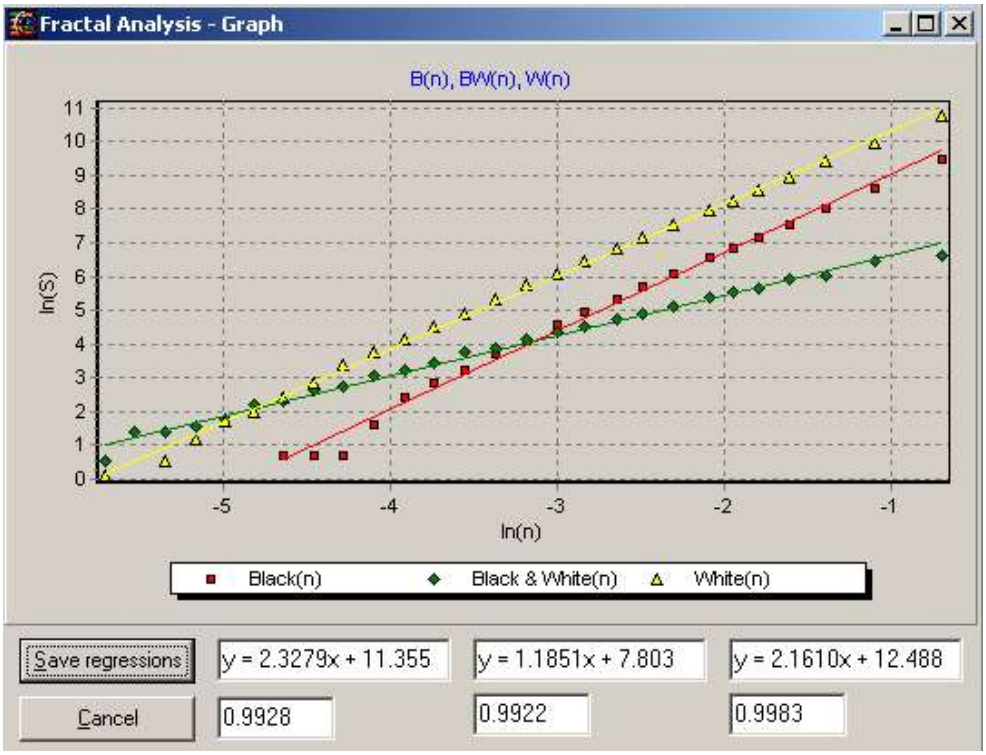

Fig.3 – Fractal dimension for Pinot noir leave

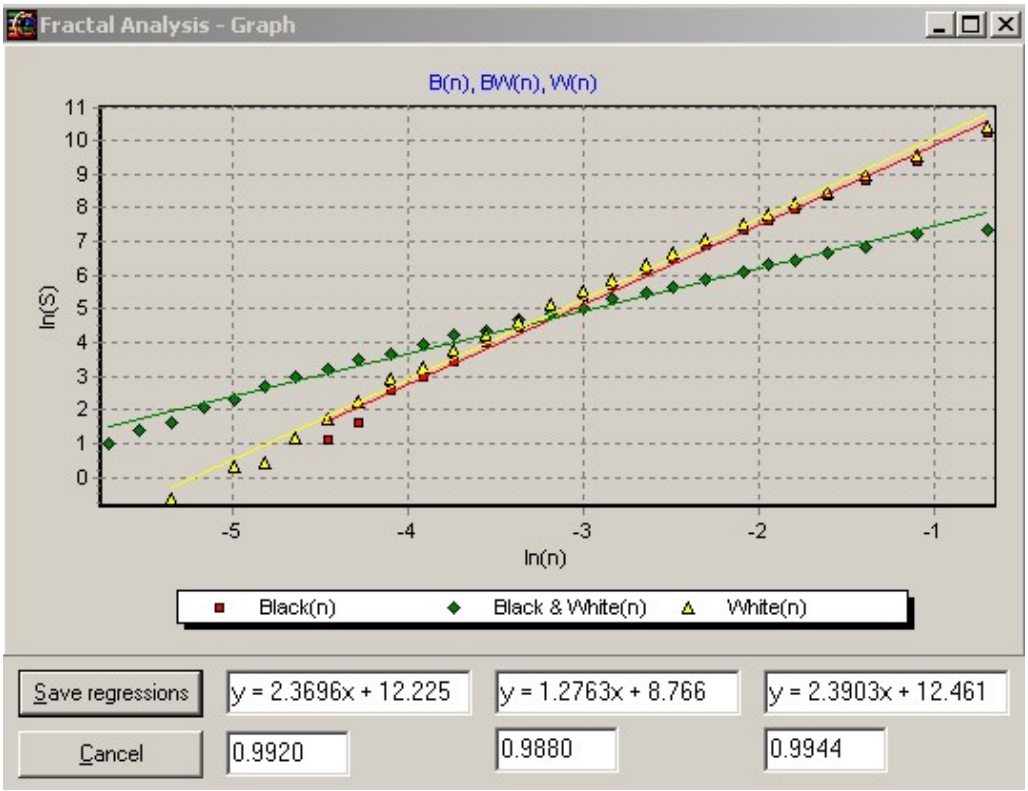

Fig.4 - Fractal dimension for Muscat Hamburg leave

Table 1

Fractal dimensions of table grapevine leaves

No. leave / Variety	Muscat de Hamburg	Muscat de Adda	Napoca	Bicane	Ceaus
1	1.2398	1.3158	1.3291	1.3255	1.3122
2	1.2763	1.2939	1.2783	1.3291	1.2915
3	1.2437	1.2827	1.3357	1.3158	1.2527
4	1.2791	1.2851	1.27	1.2478	1.3489
5	1.2465	1.267	1.2618	1.2979	1.2626
Mean	**1.25708**	**1.2889**	**1.29498**	**1.30322**	**1.29358**
Standard deviation	**0.0189**	**0.01789**	**0.0374**	**0.0332**	**0.0338**

Table 2

Fractal dimensions of wine grapevine leaves

No. leave / Variety	Berbecel	Feteasca neagră	Tamaioasa românească	Merlot	Pinot noir
1	1.2699	1.2537	1.3412	1.1808	1.1663
2	1.3504	1.271	1.246	1.2501	1.1415
3	1.2457	1.2612	1.2214	1.2833	1.2405
4	1.2444	1.2264	1.28	1.2171	1.2015
5	1.1968	1.2393	1.2763	1.2138	1.1851
Mean	**1.26144**	**1.25032**	**1.27298**	**1.22902**	**1.18698**
Standard deviation	**0.0563**	**0.0358**	**0.0368**	**0.0382**	**0.053**

We also calculated the ratio d_1/N_2, d_1 being the distance from the base of the superior sinus to the petiole point and N_2 the length of superior lateral vein by ampelometric method (13) (table 3 and table 4).

Table 3

Ampelometric values of d_1/N_2 for table grapevine leaves

Variety	Muscat de Hamburg	Muscat de Adda	Napoca	Bicane	Ceaus
Mean	0.401425	0.42602	0.493666	0.316411	0.278326

Table 4

Ampelometric values of d_1/N_2 for wine grapevine leaves

Variety	Berbecel	Feteasca neagră	Tamaioasă românească	Merlot	Pinot noir
Mean	0.559759	0.448449	0.42244	0.457845	0.652667

CONCLUSIONS

The fractal dimension could be used as a descriptive, scale-invariant, condensed, morphological parameter in ampelographic research. Our measurements permit us to obtain the following general conclusions:

1. The species of table grapevine leaves, with sectional leaves and great teeth, rare or of saw shape (Ceaus, Bicane) are characterized by great fractal dimensions and small values of ampelometric ratios.

2. The aromatic species (for table or wine grapevine) have similar fractal dimensions and also ampelometric ratios (Muscat de Hamburg, Muscat de Adda and Tamâioasă românească).

3. A good negative correlation it is found, after Colton classification (8), between the fractal dimensions and nervier ratios, the correlation coefficient being -0.9 (excluding the hybrid varieties Napoca and Berbecel).

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