DETERMINING FACTOR INFLUENCE IN THE FORMATION OF ANNUAL RINGS BY MEANS OF MULTICRITERIA ANALISYS

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Abstract

Multicriteria analisys is widely used to analyse biological phenomena, it is well known that this method provides the researchers with the opportunity of analysing a certain phenomenon by taking into account several factors. This work deals with the factors which influence the forming of annual rings at trees. Over 200 samples, taken with Pressler's borer, analysed and developed through statistic and multicriteria analisys, were the basis of this work.

Key words: annual rings, multicriteria analisys, influence factors, growth ratio.

INTRODUCTION

Radial growths vary at different heights on the stem and, as a result knowing the way the growth takes place is important in what the study of growth at trees and stands are concerned. Researches made by Assmann, Nedelcov, Zagreev [6] have shown that the width of the annual ring decreases in concordance with the increase in height, up to 12 m, where a minimum value is recorded, after which the width of the ring reaches a maximum value in the crown.

The growths in the basic area are the direct result of radial growths, which is natural if we take in consideration that the basic area is established directly on the basis of the diameter. The growth in basic area decreases from the base towards the crown, a natural outcome if we take into account the fact that the same thing occurs at radial growths as well.

The connection between the modality of distribution of the growth values at different heights of the trunk and certain dendrometrical characteristics, presented through correlation indexes, are very small [7,8] which takes us to the conclusion that there are no significant connections between them. However, a slight increase of the diameter growth values for the trees from the superior categories of heights (I,II Kraft trees) to the disadvantage of the other categories, was observed. Even so, people have noticed that the trees from the inferior height category increase their height to survive the competition [9].

The high variation with respect to trunk growth is due to the large number of factors which influence the cambial tissue, directly responsable for the growths. Among the main factors which influence notable growths

are: stational factors, climate factors, the phytocenotic position of the tree , the development possibilities of the crown and last, but not least, the applied silvotechnical measures [1,2].

Researches, made in relation to the accumulation of wood in different parts of the trunk, have demonstrated that the width of the annual rings upstream is systematically smaller, by 2-3%, than downstream [6]. This detail is important, if we keep in mind the systematic errors that can occur when samples taken with Pressler's borer are always taken from the same direction. These errors can occur in a percentage of 2-10%, sometimes even more. People started to extract samples alternatively by changing the direction of sample taking for each tree, in order to avoid these inconvenients and to obtain results as accurate as possible.

The growths have also a certain repetitiveness, caused by long-term changes in the weather. To establish the repetitiveness of the growths, determinations on a sufficiently large number of trees are needed and the determination must be done during a large span of time. According to Giurgiu this period of time comprises 50 years. Scientific research has shown that the repetitiveness of the growths is situated somewhere between 9-11 years, and for larger periods of observations, somewhere between 20-22 years. These periods have been linked to solar cycles, which comprise approximately 11 years. It is important to mention that the measuring of growths during periods from 3 to 5 years, leads to deviations related to curent growth curve, that is quantified between 10-40%. [6]. Cyclic variation can also be determined by the silvicultural breaks made in the stand or is generated by other disturbant factors: dry periods, insect atacks, grazing, pollution etc.

Using the annual ring in the study of the variation of environment factors is quite difficult and hard to mesure. The signal induced in the annual ring by environment factors is verified by statistic testing, like an information derrived from annual ring parameters.The noise is defined as non-relevant information in relation to the goals of the study [10]. The series of growths can be assimilated with time series, in the granulation of which the difference between relevant signals and noise can be achieved in the context of practical hypothesis.

Cook, on the basis, of the theoretical information presented above, has elaborated a biological model in which climate signal, age influence, the influence of endogenous and exogenous disturbances can be separated, and also respective errors [3]. The pattern elaborated by Cook is represented through multiple regression equation, shortly presented in the following:

$$R_t = A_t + C_t + \lambda D_{1t} + \lambda D_{2t} + E_t$$

In which : R_t is width of the annual ring in the year of t;

A_t – the age influence in the growth process, which is due to physiological proceses of ageing;

C_t – the climate influence on growth proceses from a certain geographical area;

D_{1t} – disturbances which occur inside the stand as a result of inter and intraspecific competition proceses;

D_{2t} – disturbances of exogenous nature, which are initiated outside the stand;

E_t – unexplained interannual variability of the annual rings (noise).

λ – binar variable (0 or 1) which expresses the presence or absence of an endogenous or exogenous disturbance.

Lining up the width of the annual ring allows for the conceptual analisys of each part. The compulsory terms of the equation are A_t, C_t şi E_t. The other two terms are present or absent directly related to the appearence of disturbances in year t.

MATERIAL AND METHODS

Multicriterial analisys can be used in many fields with great results and especially in biological sciences, where the factors react simultaneously to induce a phenomenon or a state. As a consequence, in this paper, advanced multicriterial analisys was applied. Multicriterial analisys is performed in relation to the objectively chosen criterium and gives guaranteed results.

The application of multicriterialanalisys contains 5 stages:

- establishing the criteria;
- determining the percentage of each criterium;
- identifying all te possibilities;
- giving a mark;
- the calculation of the results by multiplying marks and percentage coefficients;

Establishing the criteria is done through analisys, in such a way that the designated criteria are accurate and well defined. The criteria will be selected in such a manner that the caracterization of multicriterial analisys is without ambiguities.

Determining the percentage of each criterium is done by calculeting the percentage coefficients. The percentage of of the criteria is established with the help of a latin patern with 3 values. By comparing the criteria two at a time 3 possible values are obtained. Thus, for the most important criterium value 1 is given, for two equally important criteria a value of 0.5 is atributed, and for the least important criterium a value of 0 is given. After giving the values a square like table is obtained, having in the line and

column the respective values. At opposite ends of the square like table we can find values of 0.5, because a criterium can`t be more or less significant than itself. The sum of all points in this table is the equivalent of half of the number of criteria multiplied with itself twice. In the line the points for each criterium are added up, having a score as a result. The score value of each criterium makes these to be arranged on different levels. Level 1 is awarded to the maximum score criterium, level 2 is awarded to the second high score criterium. When criteria with equally high score occure, the value of the level will be the arithmetic average of the respective criteria in the criteria standings

Establishing the percentage of the factors in the forming of the annual rings, by multicriterial analisys, expressed itself in: determining the size of the annual rings in samples extracted with Pressler`s borer, identifying the factors which influence and interact in the forming of the annual ring and determining the percentage of the factors that interfere with forming of the annual rings by calculating the percentage coefficients.

The establishing of the percentage coefficients (γ_i) was made by using the Frisco method:

$$\gamma_i = \frac{p + \Delta p + m + 0{,}5}{-\Delta p^{i} + \frac{N_{crt.}}{2}}$$ in which:

-p is the sum of the points obtaind on the line for the calculated element;

-Δp – the difference between the score of the calculated element and the score of the element from the last level; if the calculated element is at the last level , Δp is:

-m – the number of the surpassed criteria from the scoring point of view, by the calculated criterium;

-$\Delta p^{'}$ – the difference between the calculated element and first element scores, the value being a negative one; if the calculated element is situated on the first level then $\Delta p^{'} = 0$;

-$N_{crt.}$ – the number of criteria taken into consideration.

Identifying the options is being made taking into account the obtained results. Identifying all the options is done by obtaining some percentage coefficients. The percentage coefficients express the percentage with which each criterium takes part in influencing the phenomenon. The higher the value is, the stronger the influence of that criterium is and the other way.

Giving a mark is done with numbers from 1 to 10, as a significance or contribution mark at a criterium. This mark is awarded by the analisys of

the options, from the point of view of each criterium, until all options are exhausted.

The calculation of the results obtained by multiplying the marks with the percentage coefficients is being made in a table named the matrix of consequences. The sum between the value obtained by multiplying awarded marks and percentage coefficients,is calculated, the final standings being established. Thus in first place one will find the option with the biggest sum. If the sum of the values is quite even, then the respective options ensure even performances.

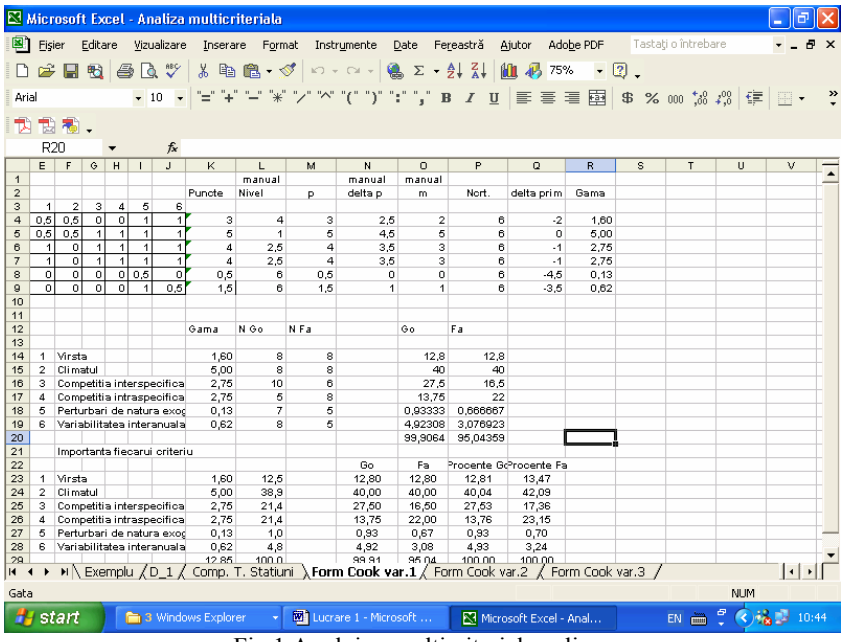

Fig.1 Applying multicriterial analisys

RESULTS AND DISSCUTIONS

Applying the multicriterial analisys to the factors which act upon the annual ring, the following values of each criterium percentage have resulted (as seen lower). In this table 3 possible options of infuencing the annual ring are presented. First option has taken into account all six criteria, the second excluded the possibility of exogenous disturbances, and the third one excuded the possibility of the exogenous disturbances and the inter and intra specific competition [4,5].

Table 1

The factor percentage in the making of the anual ring

Nr.crt.	Criterii analizate	The participation percentage in the forming of the annual ring (%)		
		Var. I	**Var. II**	**Var. III**
1	Age	12,5	10,4	24,4
2	Climate	38,9	45,1	71,2
3	Interspecific competition	21,4	21,5	-
4	Intraspecific competititon	21,4	21,5	-
5	Exogenous disturbances	1,0	-	-
6	Interannual variability	4,8	1,6	4,4

The age influence in the growth process is comprised between 10,4 and 24,4% from the total size of the annual ring. Is is interesting mentioning that the influence of the climate is situated arround 39% from the total size of the annual ring and can reach up to 71%.

The disturbances which occure inside the stand, as a result of the inter and intraspecific competition proceses have a percentage of 42,8.

The exogenous disturbances which come from inside the stand occupy a non-significant percentage in forming the annual ring (1%). The interannual variability of the annual rings (noise) occupies a more significant percentage (4,8%).

As a result of the calculations made for the sessile-oak stands and mixed stands of sessile oak with european beech from the middle basin of Crisul Repede river, the Cook equation can be written as follows:

The annual ring width = (12,5% + 38,9% + 42,8% + 1% + 4,8%) R_t

CONCLUSIONS

From those presented above a few interesting conclusions can be reached, concerning the factors percentage in forming the annual rings for the stands of sessile oak and european beech from the middle basin of Crisul Repede river:

- The age as a percentage for influencing the size of the annual ring is comprised between 10-20%, which means that it doesn`t play a decisive role in forming the annual ring;still, it is well known the fact that the size of the annual ring is strongly influenced by age in the trees from the first age category and in those who are near biological age.

- The climate has a percentange comprised between 40-70%,which shows that adapting of the species to certain stational conditions is obvious.

- The inter and intraspecific competition occupies 40%,that underlines that through silvotechnical works, properly performed, the

competition between species can be reduced, thus being created a favourable environment for significant accumulations of wood

- The exogenous disturbances occupy a non-significant part (1-4%)
- If one cannot influence the age of the climate, the silvotechnical measures complex for adjusting inter and intraspecifice competition comes in handy for the silviculturist, instead; This adjustment of the competition presents favourable implications upon growths, quality and wood selection.

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