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CONSIDERATION UPON INCREMENT OF SESSILE OAK AND EUROPEAN BEECH MIXED STAND FROM THE MIDDLE WATERSHED OF CRISUL REPEDE RIVER

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***Abstract**: With regards to growths a high variability of trunk distribution is observed due mainly to the factors which act on the cambial tissue. The factors which decisive influence formation of annual rings are: stational and climatic factors, phytocenotic position of the tree, development possibilities of the crown and last but not least the applied sylvotechnical measures. The variability of height growths is mainly due to trees competition towards light precisely the high frequency of trees with superior growths in heights. This way a height growths distribution appears with an asymmetry on the right side which becomes more present as the light competition grows. The variation coefficients of height growths have inferior values to the ones of diameter growths, a fact which can be explained because of the correlative connections between diameter and height growth. Volume growth variability is higher than radial and height growth variability. Growths in volume, if the whole stand is taken into account, are mainly determined by trees with a diameter above the medium value, which are well established in the stand and their coenotic positions allow them to accumulate the most. The work presents interesting information about the conversion of the increment cores extracted with Pressler`s borer and obtaining the size of the annual rings. The research purpose is subordinated to a larger theme which pursued biometrical and auxological determinations in order to establish growth and productivity of mixed sessile oak and European beech stands from the middle basin of Crisul Repede river. Concerning the research stages, there are medium results at national level regarding growths and productivity of the stands comprised in production charts elaborated for pure and even-aged stands, values which most of the times do not correspond to field facts, these having a purely orientative character. The counting which takes place in tested areas of 2500 sqrt was used as a method and the studied stands and computer software's used for the conversion of data were used as material of study. The work has innovative character because it shows new results concerning wood quantity accumulations and also the variations of these volumes in ratio with exhibitions and species proportions from the mixture of trees, which can be successfully used by the forest department for the increasing of stand productivity.*

Key words: *increment, stands, productivity, sessile oak, European beech*

INTRODUCTION

The high variability regarding trunk growths is due to a multitude of factors which influence cambial tissue, directly responsible of growths appearance. Among the main factors which determine significant growths are: stational and climatic factors, phytocenotic position of the tree, development possibilities of the crown and last but not least the applied sylvotechnical measures.

The growths also have a certain repetitiveness generated by lung turn changes of the weather. To establish growth repetitiveness determinations on a sufficiently large number of trees are recommended and determination has to be made on a long period of time. According to Giurgiu this period is somewhere over the next 50 years. Scientific researches have proved that repetitiveness of growths is situated somewhere between 9-11 years and in larger periods of observations somewhere in between 20-22 years. These periods have been related to solar periodicity which is somewhere around 11 years. It is important to mention that growths measuring in a period between 3-5 years leads to deviations from current growths curve which is situated between 10-40% (GIURGIU, 1967). Cyclical variation can also be determinate by sylvicultural interventions applied on the stand or it is generated by other disturbing factors: droughts, insects attacks, pasturing, pollution etc.

In even-aged stands the radial growths show some characteristics which were taken into consideration at the elaboration of the work method as well as in establishing the diameter categories from which with Pressler borrer tests were extracted. These characteristics are:

- for the same diameter category the variation coefficient of growths have reduced values between 20 – 30%
- in the same diameter category the species has a reduced influence on the variation coefficients
- the variation coefficients of the radial growths decrease from the inferior diameter categories to the superior ones, as size order these are situated between 20-25%
- in the same diameter category the variation amplitude of growths is somewhere between 0,1şi 1,9
- the variation coefficients of growths for the hole stand are bigger as values than the variation coefficients determined for diameter categories superior to medium diameter of the stand (LEAHU I., 1994).

The variability of height growths is very interesting. Is comparable to the stand distribution curve in height. An very interesting phenomenon takes place, that of height growths mainly due to trees competition for light in particular a high frequency of the trees with superior growths in height. This way the distribution of growths in height occurs with an asymmetry on the right which becomes more obvious as the competition for light is stronger. Gradually however at the same time with the decrease of stand consistency the trees competition for light decreases and, as a result, the growths in height curve get closer to the normal one. The variation coefficients of growths in height have inferior values to the ones of diameter growths, which is explainable because of correlative connections between diameter and growth in height (LEAHU I., 1999).

The variability of growths in volume is bigger than radial and height growths one. On diameter categories these values of volume growth variability or comparable to radial growth ones. If we talk about the whole stand the volume growths are mainly determined by the trees from the categories above medium diameter, trees strongly consolidated in the stands, which because of their cenotic positions become eligible for gathering the most. As an example (GIURGIU, 1979) a tree from I or II Kraft class can produce as much as 10 – 30 trees from the opposite part of the distribution curve.

The variation coefficient of growth percentage in basic area shows significant variations from one stand to another, and this happens because of stands structure and species proportion in the stand. The highest values are obtained for the central diameter categories. In ratio with the species contained by the stand, smaller variation coefficients were observed at the light species compared to shade ones. Insignificant variations of variation coefficients in the stand compared to the ones calculated for the central diameter categories were observed.

The variation coefficient of volume growth percentage shows inferior values compared to variation coefficient of basic area growth. The frequently encountered values are situated between 5-35%. Regarding the distribution, volume growth percentages it was observed that their variation has an asymmetry on the left side (GIURGIU, 1979).

The use of the annual ring for the study of the environment factors variation is often present but the extraction of the desired elements is most of the times difficult and on a number of occasions hard to supervise. The signal induced in the annual ring by the environment factors is checked with the help of statistical testing as information resulted from the annual ring parameters. The noise defines itself as irrelevant information in ratio to study objectives (POPA I., 2004). The series of growths can be assimilated to the ones of time in whose aggregation the difference between relevant sound signals and noise can be achieved in the context of a practical hypothesis.

Cook, on the basis of the above shown information elaborated a biological pattern in which the climate signal, age, endogenous and exogenous disturbances as well as inevitable errors can be separated influence (COOK E., 1990). The pattern made by Cook is synthetically presented as follows (BRIFFA K., COOK E., 1990):

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

- R_t is the annual ring width in t year
- A_t is the age influence in growth process due to aging physiological processes
- C_t is the climate influence on on growth processes from a certain geographical area
- D_{1t} represents the disturbances which appear inside the stand as a result of inter and intraspecific competition processes
- D_{2t} represents exogenous disturbances which appear outside the stand
- E_t is the unexplained interannual variability of the annual rings (noise)
- λ is binary variable (0 or 1) which expresses the presence or absence of an endogenous or exogenous disturbance

The lining up of the annual ring width makes the conceptual analysis of each part possible. The compulsory terms from the equation are A_t, C_t and E_t. The other two terms are present or absent according to appearances or disappearances of disturbances in the t year.

MATERIAL AND METHODS

In order to choose the stands the following criteria were taken into consideration:

- the stands must contain the main species of seesile oak and European beech
- the stands were chosen to be part of the IV and V age categories, the stands which are too young not being relevant in what study of growths in concerned
- the totally derived stands were excluded from the study and likewise the ones form by other species except sessile oak and European beech (artificial stands which contain resinous)
- the stands major affected by the wind and snow falls from 2003 were also excluded from the study

In the studied stands sample market of 2500 square meters were made. In order to choose the trees in which growth samples were taken the following steps were made:

- all the trees from the marked forest square, starting with an 8 cm diameter were inventoried
- the medium diameter of the trees from the testing area was determined
- the trees from which the samples would be taken were selected; these trees were selected so as to be a part from diameter categories comprised around arithmetic average

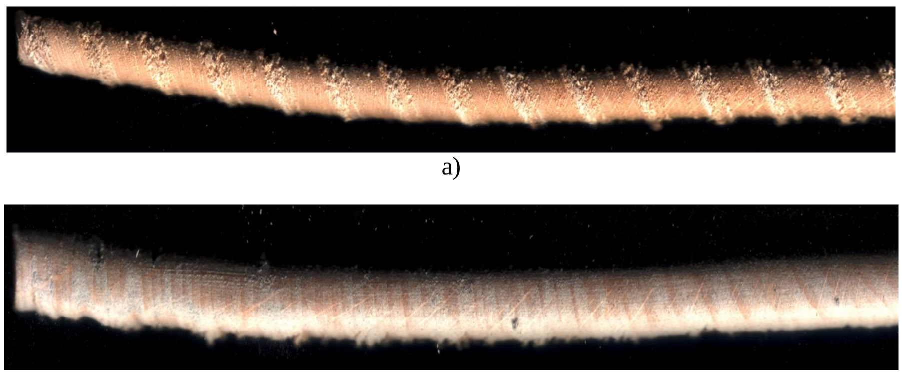
The sample number recommended to be extracted for each diameter category consist of two trees minimum. The higher the number of trees is the more relevant the data are. In order to avoid systematic errors linked to asymmetric growth in cross section the change in position of sample extraction was performed. In the case of the trees from which samples were extracted their height was measured.

The samples taken with Pressler borrer needed preparation stages before their actual measuring. The preparation stages were:

↪ determination of sample parts which belong inside and outside the radial section by visual analisys

↪ the grinding machining of the samples (especially the ones of European beech) with emery of 180 granularity; to high granularity of the paper produced detachment of chips from the sample which made almost impossible to put out the delimitation of the annual rings, on the contrary a low granularity paper (fine emery) can produce clogging of the sessile oak pores which makes the delimitation of the annual rings hard to achieve or practically impossible on certain parts of the sample

↪ the analysis of the sample after grinding with highlighting the part of the sample which belongs to the marrow and the one belonging to the cambial area



a)

b)

Figure 1 – Sample image (Fa36H28, u.a. 26B) a) before the mechanical machining of the sample b) after mechanical machining of the sample

↪ scanning of the samples was made with a special programme afferent the scanner used in the following parameters:

- brightness – 3
- contrast – 12
- gamma filter – 1,3
- scanning resolution – 600dpi
- colours scanning – 24bit
- the scanning was made on black background and saving the images was made in *bmp format

The use of scanner and set options are shown bellow:

The effective measuring of the rings presumed the following steps:

↪ delimitation of the annual rings was made through a special programme of image analysis; image analysis compared to the classic procedure allows zooming in or out the image in order to distinguish as clear as possible the place where each annual ring begins and ends and also modifications of its structure in order to highlight other characteristics of the wood (the size of early and late wood, delimitation and measuring of sessile oak pores diameter)

↪ delimitation of the annual rings was made with the mouse which draw on the image a straight line in the rings delimitation place

↪ after scrolling the hole sample image is saved with those delimitations having *bmp extension.

Obtaining the width of the annual rings was made using Distance option from

ImageTool programme.

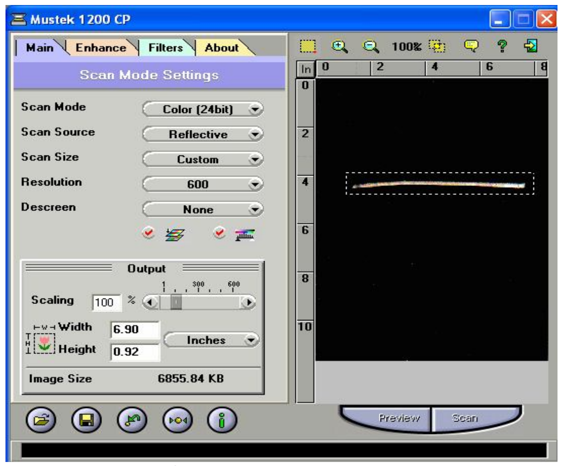


Figure 2 – Setting of the scanner in order to scan the core stage I

↪ after scrolling the hole sample the data are obtained in an Excel file, the measuring unit of the results being dpi (points/pixels)

↪ saving the result of each sample in an Excel file and converting the size of the annual rings from dpi in millimeters

For this operation of converting the pixels into millimeters the following relation was used:

The statistical machining of the basic data was made using Carota 2.1 programme (POPA I., 1999). The following statistical parameters were determined which represents the characterization indicators of the annual rings width variation (BRIFFA & JONES, 1990) as follows:

↪ the length of the dendrocronologic series which represents the number of years contained by the analyzed time series

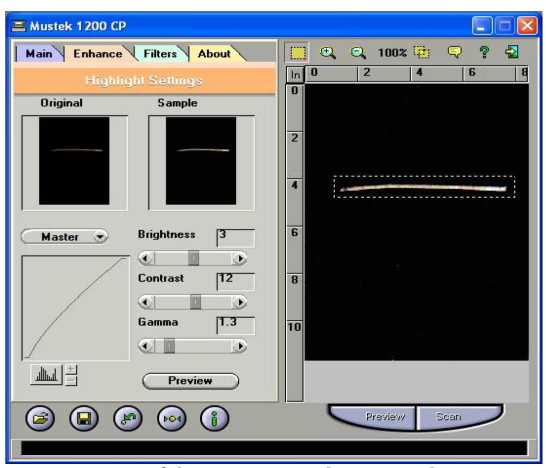


Figure 3 – Setting of the scanner in order to scan the core stage II

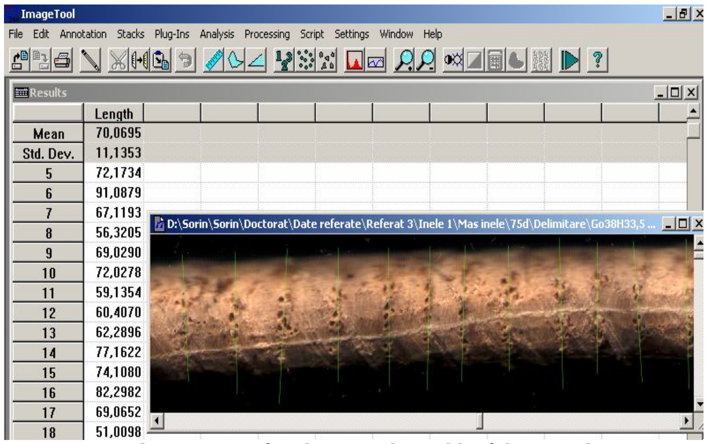


Figure 4 – Using ImageTool programme for obtaining the width of the annual rings Ring width (mm) = 0,042333*ring width (dpi)

↪ the length of the dendro-chronological series which represents the number of years included in the analyzed time series

↪ the arithmetic mean represents the average width of the annual ring

$$\bar{x} = \frac{\sum_{i=1}^{n} x_i}{n}$$ where:

- $\bar{x}$ represents the average value of the annual rings for a probe
- x_i represents the width of the annual ring in the year i
- the number of annual rings measured for a single probe

↪ variance expresses the variability degree of the dendro-chronological series

$$s^2 = \frac{\sum (x_i - \bar{x})^2}{N-1}$$ where:

- s^2 represents the variance
- $\bar{x}$ represents the average value of the annual ring for a single probe
- x_i represents the width of the annual ring in the year i
- N represents the total number of years of the dendro-chronological series

↪ standard deviation expresses the deviation degree of the individual values with respect to the arithmetic mean, and is determined by using the relation:

- s = $\sqrt{s^2}$ where:
- s represents the standard deviation
- s^2 represents the variance (dispersion)

↪the average sensitivity represents a statistical parameter specific for the dendro-chronological researches, which expresses the average percentual modification of the annual ring width with respect to the next annual ring. The high values of the sensitivity highlight the influence of the limitative factors upon the formation of the annual ring (POPA I., 2003). For the determination of this statistical parameter the following formula was used:

$$ms_x = \frac{\sum_{i=1}^{i=n-1} \frac{x_{i+1} - x_i}{\left(\frac{x_{i+1} + x_i}{2}\right)}}{n-1} \text{ where:}$$

- ms_x represents the average sensitivity
- x_i represents the width of the annual ring in the year i
- x_{i+1} represents the width of the annual ring in the year i+1
- n represents the total number of years of the dendro-chronological series

↪ the self-correlation of the order I represents the extent of the self-correlation degree belonging to the width of the annual ring in the year i with the annual ring formed in the year i+1.

For the determination of this statistical indicator, the following relation was used (POPA I., 2003).:

$$r_1 = \frac{\sum_{i=1}^{i=n-1} \left(x_i - \bar{x}\right)\left(x_{i+1} - \bar{x}\right)}{\sum_{i=1}^{i=n-1} \left(x_i - \bar{x}\right)^2} \text{ where:}$$

- r_1 represents the self-correlation of order I
- $\bar{x}$ represents the average value of the annual rings for a single probe
- x_i represents the width of the annual ring in the year i
- x_{i+1} represents the width of the annual ring in the year i+1
- n represents the total number of years in the dendrochronological series

The statistical machining of data using Carota programme led to obtaining the following data. An example is shown in the table bellow for the date obtained from the statistical machining for a sample area from u.a. 87, U.P. III Vârciorog, O.S. Dobreşti.

Tabel 1

The results of statisctical machining in u.a. 87B, U.P. III Vârciorog, O.S. Dobrești

Sample	No. of years	Medium growth	Minimum growth	Maximum growth	Variant	Standard deviation	Sensitivity	Autocorrelation
Fa22H23	52	1,38	0,38	2,81	0,42	0,65	0,30	0,64
Fa26H27	67	1,51	0,64	3,27	0,34	0,58	0,27	0,53
Fa30H27,5	67	1,73	0,51	4,28	0,86	0,93	0,34	0,47
Fa30H29,5	61	1,77	0,59	5,13	0,92	0,96	0,35	0,65
Fa34H29	62	1,88	0,72	3,51	0,57	0,75	0,25	0,74
Go22H26	64	1,20	0,47	3,68	0,48	0,69	0,22	0,76
Go22H27	63	1,60	0,59	4,07	0,60	0,77	0,23	0,78
Go26H26	71	1,40	0,68	3,01	0,19	0,43	0,20	0,60
Go26H27,5	65	1,69	0,38	5,14	1,16	1,08	0,20	0,85
Go28H27	59	2,05	0,68	5,08	0,78	0,88	0,22	0,77
Go28H27b	66	1,90	0,69	4,60	0,66	0,81	0,18	0,79
Go30H27	56	2,12	0,83	3,47	0,35	0,59	0,21	0,54
Go30H27,5	69	1,67	0,81	3,01	0,20	0,44	0,22	0,48
Go32H27,5b	70	1,85	0,76	5,15	0,91	0,95	0,17	0,89
Go32H27,5	67	1,96	0,97	3,66	0,27	0,52	0,19	0,45
Go34H27,5	56	2,21	0,59	5,21	0,89	0,94	0,27	0,58
Go34H28	63	2,38	0,90	5,02	0,70	0,83	0,19	0,70

RESULTS AND DISCUSSIONS

Comparing the productivity of the studied stands with the data obtained from the production tables led to the following synthesized results presented bellow:

↪ For sunny exhibitions (S,SE, SV) it was found that oak stands in which it appears in more than 70% growth rate compared to pure stands increase by up to 17%. From this we can conclude that resort to such exhibitions 5153 and given forest-technical work performed will have primary objective increasing the proportion of sessile oak

↪ For shadowed and half-shadowed exhibitions it was observed that in the stands in which the European beech appears in proportion of 60-70% and the rest of 60-40% is seesile oak the increasing percentage compared to the production tables is between 9-15%. In stands where beech occurs in over 80% growth rate from production tables are larger, ranging somewhere between 20% even 30%.

↪ For Western exhibitions beech and oak trees that appear in substantially the same proportions compared with the percentage increases are lower production tables by 10-15%. For exhibitions in Eastern beech and oak trees that appear in equal proportions significantly greater percentage increase by 5-15% compared to production tables

↪ For the type of resort 5153, forest type 5211 (Sessile oak-European beech-flora of Mull) on the Eastern exhibitions oak produces 4.5% more than Western shows in the same proportions to participate in the stands

↪ average growth stands of oak mixed with beech is 6.9 m^3. Results compared with average increases are contained below.

Table 2

Variation of the average increase in the proportion of species in relation to trees

Composition	**7Go3Fa-10Go**	**5Go5Fa**	**7Fa3Go-10Fa**	**Average**
Medium growth (m^3/yearr/ha)	7,65	6,57	7,29	6,99

Sensitivity values are low which shows that both oak and beech as limiting factors acting on the formation of annual rings have significant influence in their formation. . However the remaining oak trees with crowns at the higher ceiling is an increase of sensitivity, which is due primarily to limit the amount of light reaching the canopy. As the trend line sensitivity is part of a slightly downward trend from the lower classes to the upper diameter, which can be explained if we consider the limiting factors that influence puts his best mark on lower-growing specimens that have accumulated those smaller increases.

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