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THE INFLUENCE OF STAND CONDITIONS CREATED BY INTENSIVE TREATMENTS ON NATURAL REGENERATION

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ABSTRACT
To achieve the proposed objectives researches were conducted in 16 experimental blocks where intensive treatments were applied. These experimental blocks were located in all forest formations and geographic areas where these treatments have a high percent of application
Measurements and observations concerning regeneration, particular the regeneration rate on the one hand and factors influencing regeneration such as "openings" (plots), crown density of the stand, percentage of tree volume removal etc. on the other hand were made.
Quatro+ multiple regression analysis was use for statistical analysis.
After determining the main factors which influencing regeneration, it was establish their optimal size and recommendations for production have been made.
KEYWORDS: intensive treatments, natural regeneration, openings, stand condition, crown stand density

INTRODUCTION

One of the major problems of current forestry is forest conservation. The aim is to get natural ecosystems capable to maintain stable ecological balance and point the role of forests in soil erosion protection. This is why more and more insisting on applying intensive treatment to maintain uninterrupted shelter on the ground and not temporarily interrupted or reduced timber production process.

Intensive treatment methods (selection system, irregular shelterwood system and transforming cuts to selection system) are based on forest natural regeneration under the shelter of older trees and are designed to ensure the permanence of forest in the same area.

For these treatment methods, openings (plots) represent elementary area in regeneration process (Florescu, 1991). Size and shape vary according to ecological requirements of species included in composition of regeneration. They are open where regeneration exist and seedlings need to be put under the light to prevent growth stagnation or death and also where seedlings don't exist yet but there are masting (large seed crops) (Florescu 1991). Small openings (plots) are favourable for shade tolerant species. Large openings (plots) allow the installation of intermediate tolerant shade species or maintaining the species previously installed.

Experience shows, however, that in some cases, even young shade tolerant species grow well only in terms of opening to allow additional light to reach the ground (Purcelean St. 1980). In this paper we proposed to analyze the influence of stand conditions created after cutting on natural regeneration in stands that were applied intensive treatment methods.

MATERIALS AND METHOD

The researches were conducted in 16 experimental blocks located in all intensive types of silvicultural system, all forest formations and geographic area, with high share in the application of these treatments (Adam, 1992).

Stands were chosen for analysis because the predominant species in their composition were shade tolerant species like beech and fir. In most cases predominantly beech, so in terms of composition lends itself to intensive treatments. Experimental data concerning the location of blocks and basic elements of stands and type of treatment applied (within 5 years) are present in Table 1.

An experimental unit (block) consists of several experimental areas located in the average size regeneration points (patches) of each stand. For each experimental block were placed a number of experimental areas so as to ensure a statistical coverage (Giurgiu, 1972). Effective openings size was considered that part of the openings that are not under the crown and which precipitation falls directly on the surface. Its surface was calculated using the formula for ellipse surface, the formula also used to calculate the total area of openings (expanded area to marginal trees).

Table 1

Experimental block localization

No.	F. D – U.P. – C. *	Area (ha)	Natural forest type	Stand composition	Stand structure	Age (years)	Stand density	Types of silvicultural system	No. of years from cutting	Remove volume (m^3/ha)	Seedling composition	Indices for assessment of regeneration
1.	Sebiș II,45B	12,9	422.1	9FA1GO	Relative uneven -aged stand	100	0,6	Transforming cuts	5	50	9FA1GO	very satisfactory
2.	Văliug VI,27A	19,2	411.1	8FA1BR1DT	Relative even -aged stand	110	0,6	Transforming cuts	4	64	6FA4PADisTE,CA	satisfactory
3.	Văliug VI,31	22,6	411.1	9FA1DT	Relative uneven -aged stand	120	0,7	Transforming cuts	3	82	8FA1PATE1CA	very satisfactory
4.	Gîrda VI,74	47,6	134.1	6FA3BR1MODis.PA	uneven -aged stand	140	0,7	irregular shelterwood	3	94	4Fa4BR1MO1Div (PA,TE,CI)	satisfactory
5.	Văliug VI,30	18,6	411.1	9FA1DT	Relative uneven -aged stand	120	0,8	Transforming cuts	2	66	8FA1CA1PA,TE,CI	satisfactory
6.	Gîrda VI,75A	40,6	134.1	6FA4BRDisMO	uneven -aged stand	150	0,8	irregular shelterwood	3	80	4BR2FA4DIV (PA,CI)	satisfactory
7.	Reșița V,19	16,0	431.1	8BR1FA1CA	Relative even -aged stand	75	0,7	Transforming cuts	2	49	7BR3PA,TE,CI	satisfactory
8.	Resița V,18A	12,4	431.1	6FA1BR1TE1PA1CA	Relative even -aged stand	85	0,7	Transforming cuts	3	57	3FA2BR5PA,TE,CI	satisfactory
9.	Brașov V,18	25,6	212.1	9BR1FADisMO	Relative uneven -aged stand	140	0,7	Selection system	5	53	5BR4FA1MO	satisfactory
10.	Săvârșin I,83A	15,5	421.1	6FA3GO1CA	Relative even -aged stand	95	0,9	Transforming cuts	5	51	9GO1FA	very satisfactory
11.	Tg. Ocna III,78	12,8	413.1	10FA	Relative uneven -aged stand	130	0,5	irregular shelterwood	4	54	8FA2DT	satisfactory
12.	Văliug VI, 17A	16,5	221.2	9FA1DT	Relative even -aged stand	110	0,7	Transforming cuts	3	80	5FA5CADisPA,TE	poor
13.	Remeți III,29B	42,1	411.4	10FA	Relative uneven -aged stand	140	0,8	irregular shelterwood	4	80	10FA	poor
14.	Tg.Ocna V, 11D	8,6	221,2	6FA4BR	Relative uneven -aged stand	125	0,7	irregular shelterwood	4	50	5FA4BR1DT	poor
15.	Codlea III,39	29,4	411.1	10FA	Relative uneven -aged stand	115	0,9	irregular shelterwood	3	36	10Fa Dis MO,BR	poor
16.	Remeți VI,33	32,8	221.2	8FA2BR	Relative uneven -aged stand	120	0,6	irregular shelterwood	4	130	7BR3FA	very poor

*F.D. - Forest District,
U.P. – Unit of Production,
C - compartment

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Regeneration assessment was made using indices from literature (Florescu, 1991)

- Very good, the area is regenerated in the regeneration rate of over 95%;
- Satisfactory, when regeneration was carried out between 75 and 95%;
- Poor, when seedlings occupy less than 75% of regeneration area, but there is the possibility of natural installation of another seedlings;
- Very weak, when seedling density is not sufficient and there is not possibility of natural seedling installation for different causes.

Regeneration assessment was considering the possibility to achieve a certain goal compositions like it is prescribed in management plan. In each experimental area were placed surveys of study at a distance of five meters apart from the middle of the plots to the four cardinal directions (North, East, South and West) by its edge. Directions were determined with topographic compass and distances were measured with tape measure, taking into account the slope. Each surveys area is 1 m2 and numbered stakes have been installed in their middle. Counting seedlings was done by species.

It was considered appropriate regeneration percentage ratio between the number of surveys adequately regenerated and total surveys (the whole plots in the study). An appropriate regenerated survey means at least two viable seedlings from dominant species.

Production class was determined to one decimal place, weighing the elements of stand for studied species. There has been taken in account crown density from the neighbourhood plots (generally this do not varied by more than one unit from the average stand density).

The average percentage of grassing has been determined for each studied plot. The regeneration cutting applied within five years has been various according with harvesting intensities and plots sizes. The aim was to establish some correlation between created stand conditions and regeneration process.

A multiple regression analysis (using the QUATRO+ programme) was made. For each stand was taken as dependent variable (y) the percentage of the total area with adequate regeneration and the independent variables (x): class production, volume per hectare, crown density of the stand, the percentage of volume harvesting, the actual openings size, the total area of the openings, and the number of years from cutting and the average percentage of grassing.

Using multiple regression analysis was determined by finding similarities between data set of value y (dependent variable) and data set of value x (independent variable). Analysis of similarity (from forms of recognition theory) can notice that between two data sets of values considered as vectors (in which one is the dependent and the other one the independent factor) there is similarity. We consider a cosine the size of similarity function:

$$\cos(y,x) = \frac{\sum_{i=1}^{n} y_i x_i}{\sqrt{\sum_{i=1}^{n} y_i^2 \cdot \sum_{i=1}^{n} x_i^2}}$$

Where : $\sum_{i=1}^{n} y^2$ is norm y_i

$\sum_{i=1}^{n} y_i \cdot x_i$ - scalar product

How much the cosine values are closer to 1 (cosine value for the vector which is the dependent factor and is the reference) then the similarity is higher.

Returning to multiple regression analysis we note that this represents a possibility to assess the conditioned factors participation in achieving a specific value. We mentioned that the calculated regression equations are empirical and are based on the knowledge of investigated phenomenon causality. Some factors that come into account are synergistic.

RESULTS AND DISCUSSION

Using seven degrees of freedom for the eight analyzed factors, it has been obtain a squared value of multiple correlation coefficient R^2 = 0.830811 which means that 17% of total variation remained unexplained by considering the 8 explanatory characteristics. In this case confidence interval of the theoretical regression equation will be Y ± 37.39753.

In Table 2 are presented for the eight factors analyzed the values of partial regression coefficient values, the values of reports tbi =bi/Sbi and the similarity sequence between the data set of dependent variable and the data set of independent variables.

Following Figure 1 we can notice that the highest percentage of regression coefficients participation is the one that characterize the factor C (crown density of stand) whose value is 81.9%. However, it is noted in Figure 2, that the highest standard error of regression coefficients corresponds to factor C.

Theoretical value of t statistics for this case (7 degree of freedom) is 2.365 for a 5% probability of transgression and 1,895 for a 10% probability of transgression. Table 2 shows us that the E factor (the real area of openings; tbi= - 2,517x) has the greatest influence on the studied phenomenon. This is correlated with a high value of regression coefficient characterizing crown density of stand and makes us believe that light has a decisive role in the regeneration process for all studied stands.

Table 2

Significance of partial regression coefficients analysis

Stand characteristic analyzed	*Volume cm/ha*	*Class production*	*Stand density*	*Percent of removal*
symbol (factorial characteristic x_i)	$A_{(x1)}$	$B_{(x2)}$	$C_{(x3)}$	$D_{(x4)}$
Norm	1676,18	10,71	2,87	67,00
Cosine	0,93	0,92	0,96	0,80
Order	3	4	1	7
Partial regression coefficient value bi	0,024024	-32,1321	-210,534	-3,22912
standard error of regression coefficient value Sb_i	-0,083664	19,83584	104,2484	1,509217
Participation percentage b_i(%)	0,0	12,5	81,9	1,3
$t_{bi} = b_i/Sb_i$	0,287236	-1,6199	-2,01954	-2,1396
Stand characteristic analyzed	***Effective openings area (m^2)***	***Total openings area (m^2)***	***No. of years from cutting***	***Average percentage of grassing***
symbol (factorial characteristic x_i)	$E_{(x5)}$	$F_{(x6)}$	$G_{(x7)}$	$H_{(x8)}$
Norm	675,96	1629,45	13,71	176,31
Cosine	0,94	0,91	0,90	0,67
Order	2	5	6	8
Partial regression coefficient value bi	-0,25961	0,011774	10,82199	-0,11732
standard error of regression coefficient value Sb_i	0,103144	0,045628	5,274383	0,308755
Participation percentage b_i(%)	0,1	0,0	4,2	0,0
$t_{bi} = b_i/Sb_i$	-2,517[x]	0,258032	2,051802	-0,37997

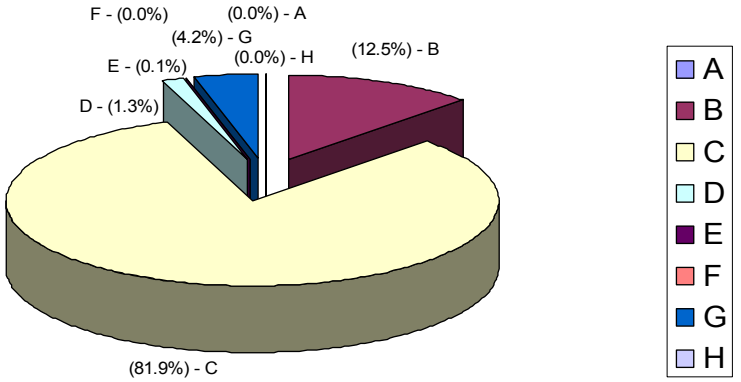

Fig. 1 The influence of stand conditions on regeneration expressed through partial regression coefficients percentage participation

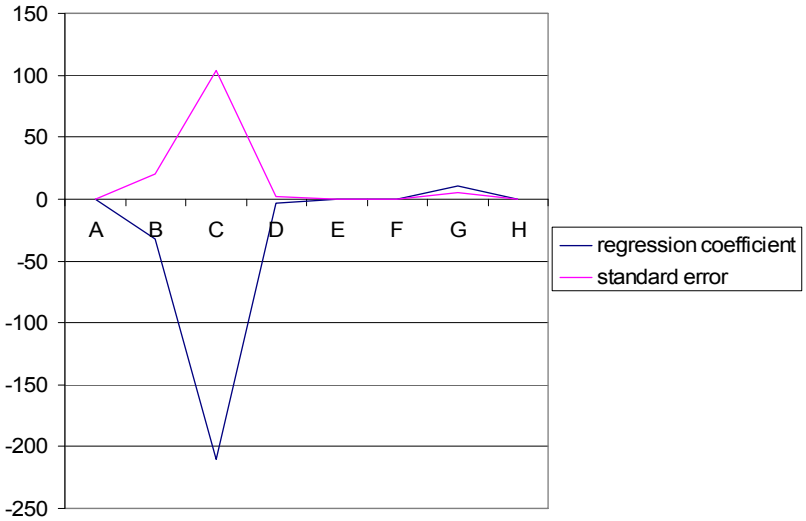

Fig. 2 Distribution of partial regression coefficients and standard errors in the analysis of stand conditions influence over regeneration

Considering a 10% probability of transgression, as shown in Table 2, the next factor that influenced regeneration process is the percentage of removal tree volume. But this is the interdependence with crown density of stand having experimental values very close to t characteristic. Also for a 10% probability of transgression, the number of years from cutting date influence also regeneration process.

In this context, taking into account stands with satisfactory and very satisfactory regeneration process, it is found that the average area of openings is less than 100 m2 (98 m2) which corresponds to a total area of openings less than 400 m^2 for most cases.

The average value area for openings is different for stand with low regeneration (159.8 m^2) and stands with very low regeneration (285 m^2).

On the rate of removal tree volume, we can note that the average is 13% for both kinds of stands with very satisfactory and satisfactory regeneration process.

For stands with low regeneration there has been obtained an average of 18.5% and for stands with very low regenerating stands averaged 19.2%. Talking about crown density of stand, their average values are 0.74 for stand with satisfactory and very satisfactory regeneration. The average value about crown density of stand is below 0.7for stand with low regeneration (0.65) and very low regeneration process (0.63). The average percentage for grassing is low for stands with very satisfactory regeneration process (17.5%) and high value for stands with very low regeneration process (66% but in most cases having values more that 75%). Mean values for the other stands are intermediate. We are talking about 34.4% for stands with satisfactory regeneration and 38.5% for stands with very low regeneration. Regarding the percentage of grassing, an important role has the local forest experience. Foresters know for all forest situations when this process appears depending on crown density of stands and openings sizes.

In conclusion, it is recommended that when applying intensive treatment methods in stands similar to those previously analyzed, the openings sizes do not exceed 500m2, the percentage of removal tree volume should not exceed 14% and crown density of stand to not fall below 0.7, otherwise grassing occurred and generally speaking the natural regeneration process with shade tolerated species becomes is difficult or impossible.

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