Auxological and dendochronological parameters analysis in the spruce cultures installed outside the range in Suceava County

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Abstract In order to obtain an increased biomass quantity for the cellulose and paper industry, during 1948 – 1986, resinous cultures were introduced in Romania, beyond the natural vegetation range characteristic for these species. Under the influence of climatic factors and secondary pests (bark beetles), in the last decade, the situation of these forest stands has aggravated significantly, the mass drying phenomenon being noticed on increasingly large areas annually. In order to find the optimum means of conversion for these cultures, it is necessary to perform detailed studies regarding structural parameters, the state of health and modifications brought on stational conditions. The hereby study proposes to analyze such a forest stand 30 from the installment.

Material and Method

The researches were performed in the d.u. (developmental unit) 28A, U.P. I Todiresti, Range Forest Patrauti, Forestry Department Suceava (figure 1). The developmental unit has an area of 23.9 ha, is located at an average altitude of 385 m, and it is made of pure forest stands of 30-year old spruce. In 1995, the following thinning variants were applied:

- V1 – diagonal corridor, 4 standing rows and 1 cut row
- V2 – diagonal corridor, 4 standing rows and 1 cut row
- V3 – diagonal corridor, 5 standing rows and 1 cut row
- V4 – diagonal corridor, 6 standing rows and 1 cut row
- V5 – diagonal corridor, 5 standing rows and 1 cut row
- V6 – diagonal corridor, 6 standing rows and 1 cut row

Due to the precarious state of this forest stand, one of the priorities is represented by the ecological reconstruction of the affected areas. The hereby study proposes to analyze such a forest stand in relation to the auxological and dendochronological parameters.
For the auxiological parameters analysis, the following types of sampling areas were installed:

- 17 sampling areas of 400m², (20*20m²), located by a 50*50m² raster on the entire area of the developmental unit
- 28 sampling areas of different sizes located inside the thinning variants

The installed sampling areas, all the existent trees and stubs were inventoried, registering the following characteristics in the field sheet, tree diameter at a 1.30 m height, stub diameter root collar, tree height and state of health.

The growth samples collection for the purposes of measuring the yearly rings width was performed with the Pressler drill, at the 1.3 m height. In order to observe the effect of applying different thinning intensities on the yearly growths, the drill cores were sampled for each thinning variants in part. Finally, a number of 84 drill cores was obtained which, subsequently, were measured in the Lintab devices, using the TSAP Win program. The statistical processing of the growth series was performed according to the methodology in force (4).

In order to analyze the influence of the main climatic factors, the values existing in the CRU (Climatic Research Unit) were extracted and processed, values regarding the monthly and yearly average temperature and precipitations for the ecological sub-region J1 – Suceava Plateau. The influence of the precipitations quantity on the yearly growths was analyzed using the standardized precipitation index SPI (2).

### Results and Discussions

After placing the 17, 400 m² sample surfaces, a number of 933 trees were catalogued (~55 trees on the sample surface) and 447 stubs (~26 stubs in each surface) whose biometric characteristics have been resumed in table 2. An average number of 1372 trees per hectare has resulted with an average volume of 416.5m³/ha. We notice the over unitary value of the slenderness coefficient (Dg/Hg), which denotes a better resistance capacity of this forest stand under the action of the wind.
From the probes installed on different types of thinning applied we notice that variant V2 (longitudinal corridor, 4 rows standing and 1 cut) has the lowest number of trees per hectare (1150), on the other hand we have variant V5 (diagonal corridor, 5 rows standing and 1 cut), with 1614 trees per hectare.

To eliminate age influence, when analyzing the dendochronological series growing indexes were used, calculated as standard deviation from the annual average growth. Due to the very different growths in the first years of the saplings, the years 1980, 1981 and 1983 were eliminated from the growing series. Thus, the obtained series have a period of 27 years (Fig.3). It is ascertained that there are no significant differences within the same thinning variant in the growth of trees from the edge of the open corridor, compared to those within the respective variant. Taking into consideration...
that, from one variant to another, the growth differences are very small, the SPI index variation was represented graphically only for the V2 thinning variant. Along with the implementation of these thinning types in 1995, a significant acceleration of the increases for the next 2-3 years is noticed for tall the variants. This thing can be justified by the intraspecific competition reduction through the thinning implementation, since it is noticed that, even though in 1997 the SPI index value begins to decrease, the increases remain at values relatively high compared to the average.

![Radial growth dynamics](image)

**Fig. 3** The radial growth dynamics for the applied thinning variants

The identification of climatic parameters with influence on radial growths was performed by the correlation analysis. In the case of precipitations, the SPI index was calculated with the formula: 

\[ SPI = \frac{Pi - Pm}{SD} \]

where:

- SPI – standardized precipitation index
- Pi – average monthly precipitations
- Pm – average multi-annual precipitations
- SD – standard deviation

Table 3 presents the values of the correlation coefficient \( r \), between the SPI index and the growth indices for the trees from the studied thinning variants. It is noted that the highest influences are caused by the average precipitation quantity accumulated during the summer season, and the average precipitation quantity accumulated during the winter season, especially those from the month of December of the previous year.
The correlation coefficient r between the SPI precipitation indices and the growth indices

<table>
<thead>
<tr>
<th>Variant</th>
<th>D (I-1)</th>
<th>I</th>
<th>F</th>
<th>Winter</th>
<th>Spring</th>
<th>July</th>
<th>I</th>
<th>A</th>
<th>Summer</th>
<th>Autumn</th>
<th>W+S+S+A</th>
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<tbody>
<tr>
<td>V2R</td>
<td>0.33</td>
<td>0.16</td>
<td>0.14</td>
<td>0.35</td>
<td>0.12</td>
<td>0.19</td>
<td>0.30</td>
<td>0.15</td>
<td>0.38</td>
<td>0.15</td>
<td>0.40</td>
</tr>
<tr>
<td>V2l</td>
<td>0.43</td>
<td>0.13</td>
<td>0.13</td>
<td>0.38</td>
<td>0.23</td>
<td>0.15</td>
<td>0.40</td>
<td>0.15</td>
<td>0.41</td>
<td>0.30</td>
<td>0.54</td>
</tr>
<tr>
<td>Average V2</td>
<td>0.39</td>
<td>0.15</td>
<td>0.14</td>
<td>0.38</td>
<td>0.17</td>
<td>0.17</td>
<td>0.36</td>
<td>0.16</td>
<td>0.40</td>
<td>0.15</td>
<td>0.48</td>
</tr>
<tr>
<td>V3R</td>
<td>0.24</td>
<td>0.02</td>
<td>0.02</td>
<td>0.16</td>
<td>0.13</td>
<td>0.18</td>
<td>0.40</td>
<td>0.07</td>
<td>0.40</td>
<td>0.14</td>
<td>0.37</td>
</tr>
<tr>
<td>V3I</td>
<td>0.32</td>
<td>0.01</td>
<td>0.10</td>
<td>0.24</td>
<td>0.16</td>
<td>0.25</td>
<td>0.39</td>
<td>0.01</td>
<td>0.41</td>
<td>0.11</td>
<td>0.40</td>
</tr>
<tr>
<td>Average V3</td>
<td>0.28</td>
<td>0.02</td>
<td>0.05</td>
<td>0.20</td>
<td>0.14</td>
<td>0.22</td>
<td>0.40</td>
<td>0.05</td>
<td>0.41</td>
<td>0.13</td>
<td>0.39</td>
</tr>
<tr>
<td>V4R</td>
<td>0.15</td>
<td>-0.14</td>
<td>-0.09</td>
<td>-0.04</td>
<td>0.31</td>
<td>0.21</td>
<td>0.27</td>
<td>-0.11</td>
<td>0.25</td>
<td>0.06</td>
<td>0.29</td>
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<tr>
<td>V4I</td>
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<tr>
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<td>0.01</td>
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<td>0.19</td>
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<td>V5R</td>
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<tr>
<td>V5I</td>
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<td>0.07</td>
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<tr>
<td>Average V5</td>
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<td>0.00</td>
<td>0.12</td>
<td>0.31</td>
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<td>0.11</td>
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<tr>
<td>Average V</td>
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<td>0.06</td>
<td>0.09</td>
<td>0.30</td>
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<td>0.18</td>
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<td>0.12</td>
<td>0.45</td>
<td>0.15</td>
<td>0.52</td>
</tr>
</tbody>
</table>

A clearer image is presented in figure 4, where the correlation coefficient r between the SPI precipitation indices and the growth indices was transposed graphically per total variants. The average correlation coefficient values below 0.2. Precipitations from the autumn months (S, O, N) and the spring months (M, M) have the lowest influences on the annual growths, with correlation coefficient values below 0.2.

The direction and intensity of the correlation coefficient r between the average monthly and seasonal temperatures and the growth indices are presented in figure 5. It is noticed that the radial growths are correlated negatively with the average values of monthly and seasonal temperatures. The strongest correlation with the growth indices (r = -0.589) is generated by the average monthly temperatures from the month of December of the previous year.
Conclusions

It can be said that, for the spruce installed outside the range, the precipitation quantity represents the main climatic factor with direct influences on radial increases. From these, the quantity of precipitations from the winter season and the summer season has a significant repercussion on radial growths. It is surprising that, even though the quantity of precipitations accumulated during the winter season influences the growth significantly, the precipitations from January and February have an insignificant influence, the strongest correlation being given by the precipitations from December of the previous year. This thing can be explained by the fact that, many times, in December, since the soil is still frozen, the water from precipitations reaches the soil and remains there as a reserve, for the commencement of entry in vegetation of spring. Instead, in January and February, with the soil still frozen, a large part of the precipitation quantity does not enter the soil and, therefore, it does no longer influence the radial growth in a significant way.

The results obtained in this study confirm previous researches according to which the radial growths are influenced more by average precipitations accumulated during the winter season and the summer season, compared with the average precipitations accumulated during spring and autumn.

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