Some Major Structural Characteristics of a Silver Fir-Dominated Stand in the Lignum Forests (Bacău County, east of Romania)

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Abstract

The paper presents the results of a project dealing with the structural characteristics of a silver fir (*Abies alba* Mill.)-dominated stand (including Norway spruce, European larch, European beech, hornbeam, etc. as secondary tree species), 25 years old and naturally regenerated by uniform shelterwood cuttings.

In spring 2012, three research & demonstration plots (RDP1, 2, and 3) of 450 sq.m, 400 sq.m and 300 sq.m were established. In RDP 1 and RDP 2 cleaning-respacing interventions with different silvicultural objectives and intensities were carried out while RDP3 was kept as control. In all plots, *potential final crop trees* (between 400 and 489 trees/ha), mostly of silver fir, were selected based on the *vigour-quality-spacing* criteria.

The main results of the field measurements and office analyses are as follows:

- owing to the exceptional regeneration potential of silver fir, as well as its high shade-tolerance, the initial stocking of living trees was over 10,000 stems in all plots. After intervention the stocking varies between 1,350 trees/ha in RDP 2 and 10,032 trees/ha in control plot;
- following intervention stand basal area was reduced to 10.87 sq.m/ha (RDP2) and 20,25 sq.m/ha (RDP1); basal area shows the maximum value in control plot (31.65 sq.m/ha);
- the mean diameter ranges between 5.60 cm (control plot) and 10.19 cm (RDP2);
- the mean height is less variable than the mean diameter and ranges between 7.56 m (control plot) and 8.42 m (RDP 2);
- the mean slenderness index *h/d* is the highest (over 130) in control plot and lowest (96) in RDP2;
- the variability of potential final crop trees in terms of their mean diameter, mean height and mean slenderness index is much lower than in case of overall trees found in the three R&D plots.

Key words: Silver fir, *Abies alba*, stand density, mean values, basal area

Introduction

Silver fir (*Abies alba* Mill.) is a major conifer species in Romania, covering about 300,000 ha (5% of national forest land) (Giurgiu, 2005). The species is found in both pure and mixed stands (especially with Norway spruce *Picea abies* (L.) Karst and/or European beech *Fagus sylvatica* L.) and such forest ecosystems are very productive and stable (Nicolescu, 2005).

Depending on their structure and functions to play, such stands are managed/regenerated either using selection cuttings (uneven-aged stands, providing protection functions) or shelterwood cuttings (both group and uniform, in even-aged stands providing mostly production functions).

In order to promote the natural pruning of silver fir trees (in Romania they are traditionally considered as "able to prune themselves well under dense stand conditions" - Negulescu and Săvulescu, 1965; Stănescu, 1979; Şofletea, 1997), young stands are tended lightly (i.e. kept dense after interventions) or even left untended (without any intervention until mid-sapling stage). Consequently such very dense young silver fir stands include tall and thin trees, with high slenderness indices (*SI = h/d*) and are quite fragile and very prone to snow damages, as stressed long time ago (Jolyet, 1916).

Taking into account these issues, a research and demonstration (R&D) project has started in 2012, aiming to emphasize the structure of young silver stands in relation to various silvicultural strategies (including the early choice and marking of potential final crop trees, as well as artificial pruning).

Material and Methods

In spring 2012, three research & demonstration plots (RDP1, 2, and control) of 450 sq.m, 400 sq.m and 300 sq.m were established in sub-compartment 105B (area 5.7 ha, elevation 570 m, horizontal land; natural vegetation: mixed silver fir-Norway spruce-European beech stand of high productivity), Working Unit I Nemira, LIGNUM Private Forest District (Dărmăneşti-Bacău, east of Romania).

The stand is a silver fir-dominated one (including Norway spruce, European larch *Larix decidua* L., European beech, hornbeam *Carpinus betulus* L., Scots pine *Pinus sylvestris* L., etc. as secondary tree species), 25 years old and naturally regenerated by uniform shelterwood cuttings.

In RDP 1 and RDP 2 intermediate (*from above* + *from below*) cleaning-respacing interventions with different silvicultural objectives and intensities (over 25% by number of trees – *very heavy* according to the Romanian system of classification - in both RDPs) were carried out while RDP3 was kept as control.

In all plots, *potential final crop trees*, mostly of silver fir but also of Scots pine or Norway spruce, were selected based on the *vigour* (the thickest from the dominant canopy, with large and balanced crowns) – *quality* (without defects, with thin branches) and *spacing* (as regularly distributed as possible) criteria.

In addition, due to the very high stand densities and lack of inner access, parallel extraction racks (2 m wide, 25 m between their axes) were opened. This operation was combined with low artificial pruning (up to 2 m height) as the existing silver fir trees, opposed to the „traditional" beliefs, were not naturally pruned and their lower branches, even dead/dry but remaining attached to the trunk, made the access almost impossible.

Results and Discussion

The main results of the field measurements and office works are as follows:

1. Silver fir is the dominant species (before and after intervention) within the three plots, its proportion varying between 70% (RDP2) and 88% (RDP1) by number of trees and 76% (RDP2) and 85% (RDP1) by basal area. All shade-tolerant tree species such as European beech or hornbeam as well as some smaller silver fir trees were preserved or even promoted to (a) shade the lower stem of silver firs and prevent occurrence of epicormic branches, (b) help dying of lower branches and also (c) provide soil protection. Such understory should be preserved as long as possible because, as stressed by Broilliard (1881): "A silver fir stand without understory is in a critical situation".

2. Owing to the exceptional regeneration potential of silver fir, as well as its high shade-tolerance, the initial stocking of living trees was over 10,000 stems in all plots. After intervention the stocking varies between 1,350 trees/ha (RDP 2), 3,111 trees (RDP1) and 10,032 trees/ha in control plot.

3. Following cleaning-respacing stand basal area was reduced between 10.87 sq.m/ha (RDP2) and 20.25 sq.m/ha (RDP1); basal area shows the maximum value in control plot (31.65 sq.m/ha).

4. The mean diameter of remaining trees ranges between 5.60 cm (control plot), 8.58 cm (RDP1) and 10.19 cm (RDP2);

5. The mean height of remaining trees is less variable than the mean diameter and ranges between 7.56 m (control plot), 8.16 m (RDP1) and 8.42 m (RDP 2).

6. The mean slenderness index *h/d* of remaining trees is the highest (over 130) in control plot and lowest (96) in RDP2; in RDP1 the mean slenderness index is 99.

7. In case of *potential final crop trees* the main structural characteristics, with a much lower variation than in case of „normal", overall trees of the three plots, are the following:

- number of trees per ha: between 400 (control plot), 475 (RDP2) and 489 (RDP1). It is much higher (almost double) than the one (200-280 trees/ha) proposed as final crop trees in France by Allegrini and Depierre (2000), Bastien (2001), and Allegrini (2010).
- mean diameter: between 11.36 cm (RDP2), 11.53 cm (control plot) and 11.89 cm (RDP1).
- mean height: between 8.90 cm (RDP2), 9.71 cm (control plot) and 9.80 cm (RDP1).

- mean slenderness index: between 81 (RDP2), 84 (RDP1) and 87 (control plot).

In addition, owing to the dimensional variation within the three plots, the potential final crop trees are rather irregularly distributed as shown in Figure 1.

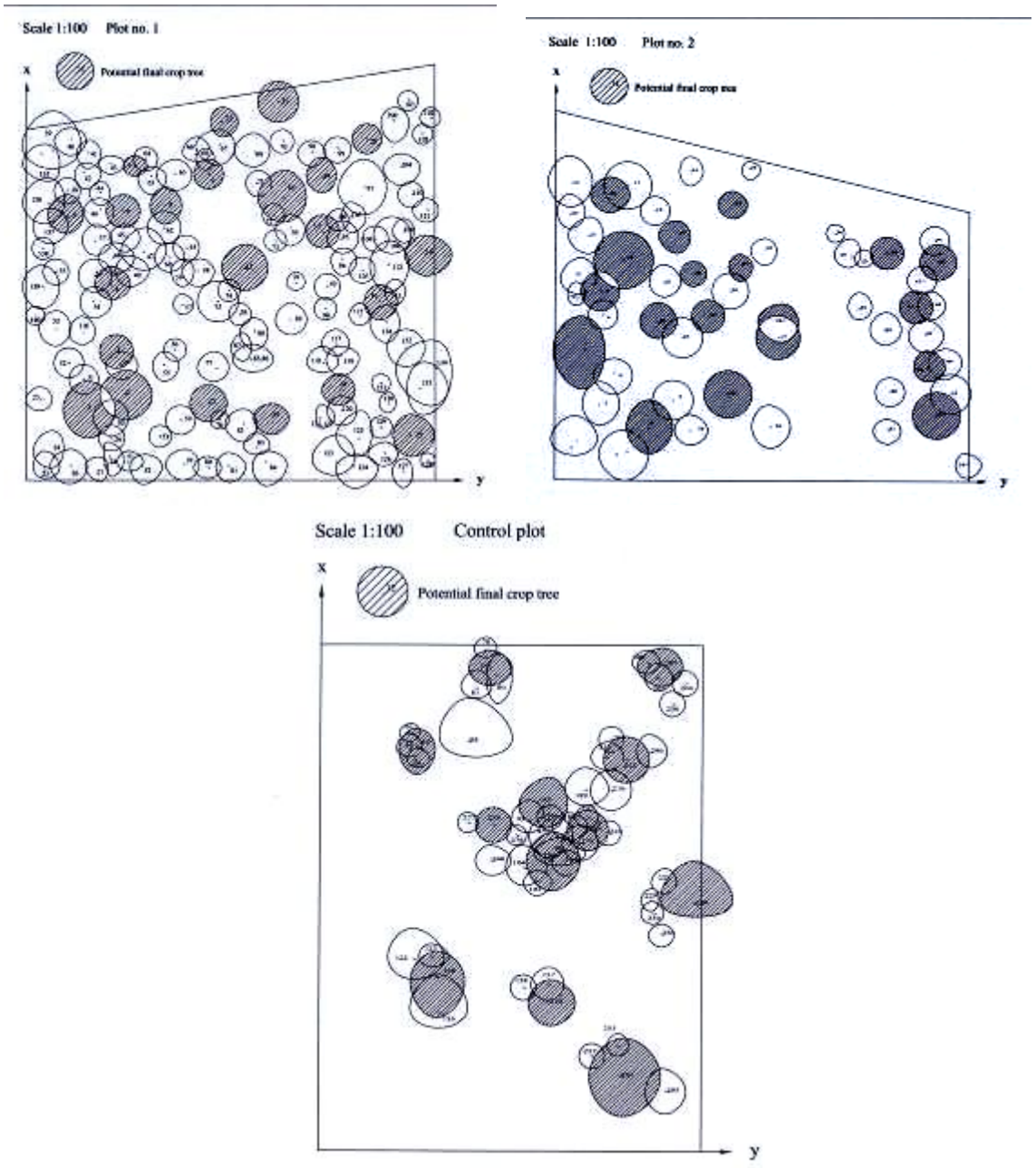

Figure 1. Horizontal projection of trees in plots 1, 2, and control

Obviously, such undesired situation will be subsequently „corrected" during the application of thinning, when the selection of „genuine" final crop trees (maximum 300 individuals/ha), based on the *vigour-quality-spacing* criteria, will be carried out.

Conclusions

As this R&D work has started only in the current year, it is hard and also early to draw too many conclusions. However, based on these preliminary results, the following aspects should be emphasized:

1. The density of naturally regenerated silver fir-dominated is very high during the early stages of development and leads to very high canopy closures and basal areas.

2. The operation of cleaning-respacing should include the choice and marking of *potential final crop trees*. These trees (no more than 500 per ha) should be subsequently favoured by thinning acting especially in the upper part of canopy (*intermediate thinning* or *thinning from above*), as recommended by Constantinescu (1976), Marcu (ed.) (1980), Lanier (1986), Anonymous (1986), Boudru (1989), Anonymous (2000).

3. Natural pruning of silver fir trees is weak even under high stand densities therefore artificial pruning removing dead, dying as well as living branches is compulsory when production of high-quality timber is desired.

4. One major challenge for the future interventions within such dense stands is the low accessibility due to the absence of extraction racks. They should be opened during the earlier (cleaning-respacing) interventions as proposed in both Romania (Anonymous, 1986; Anonymous, 2000) and abroad (Lanier, 1986; Demarcq, 1996).

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