DOI: 10.20315/SilvaSlovenica.0026.02

Antonín Martiník[1], Marie Matoušková[2], Josef Urban[2]

Calamities: A chance to increase proportion of silver fir

KEYWORDS: disturbance, pioneer species, nurse crop

Introduction

Central European forestry has been strongly influenced by traditional German (Saxony) forest school, which leads to a change in species composition. The present proportion of silver fir in the Czech Republic is around 1 %, whereas the natural should reach 20 % (Zpráva 2021). The traditional way to increase the proportion of this species is associated with the conversion of Norway spruce stands, where fir is artificially regenerated (planted and seeded) under the shelter of Norway spruce trees (Spiecker et al. 2004; Huth et al. 2017). On the other hand, for the process of reforestation of large clearings, silver fir is not so not well-adapted (Korpeľ and Vinš 1964), as it is slowly growing, shade tolerant, and very sensitive species to climatic extremes (Korpeľ and Vinš 1964). On the other hand, Volařík and Hédl (2013) found a high proportion of silver fir in the regions that were strongly deforested and where forest nature expansion occurs.

We discuss the use of silver birch as a preparatory species in the artificial regeneration of silver fir. Some results of experiments established in 2015 in the Czech Republic are presented.

Material and Methods

All experiments were performed in the plots that are located in the eastern part of the Czech Republic. In total, 10 experimental plots – Padělky, Mokřinky, Krůtí, Bílá, Rakovec, Tornádo, Stará Ves, Hlubočec I, II, Skrchov represented middle rich and rich soil of oak-beech, beech and fir-beech vegetation zone. In these plots we observed the spontaneous regeneration of silver fir (Padělky, Mokřinky); evaluated the seeding experiment (Krůtí, Bílá, Hlubočec I) and analysed the nurse crop method with pioneer and silver fir. Height increment was calculated from the heights of all 70 initially planted silver firs measured between 2016 and 2018 in Skrchov. Shoot water potential in Skrchov was measured on 6-7 firs per treatment during midday on 23 August 2018 and before predawn on 24 August 2018. Light response curves of photosynthesis were measured in Stará Ves during 21 August 2023 on 7 firs per treatment and radial increment of Silver fir stems was measured during the vegetation season of 2023 on three firs per treatment.

[1] Department of Silviculture, Faculty of Forestry and Wood Technology, Mendel University, Zemedelska 3, 613 00 Brno, Czech Republic

[2] Department of Forest Botany, Dendrology and Geobiocenology, Faculty of Forestry and Wood Technology, Mendel University, Zemedelska 3, 613 00 Brno, Czech Republic

Corresponding author: Antonín Martiník - antonin.martinik@mendelu.cz

Results

In the first experiment, we try to understand the “pioneer behavior" strategies of silver fir. We established the seeding experiment in two clearings: one represented the optimum (Bílá: fir-beech vegetation zone) and the second sub-optimum (Krůtí: oak-beech zone) for silver fir introduction. The germination was similar at both sites. Higher survival rates were on the optimum site, but due to strong weed competition, the success of Silver fir was low, at 2 % (Fig. 1). We found higher regeneration success under the canopy of nurse trees than at the clearing. In the other experiment, where seeding of Silver fir was carried out in about 15-year-old pioneer silver birch dominant stand, the yield of seed exceeded 7 % after 5 years (Hlubočec I).

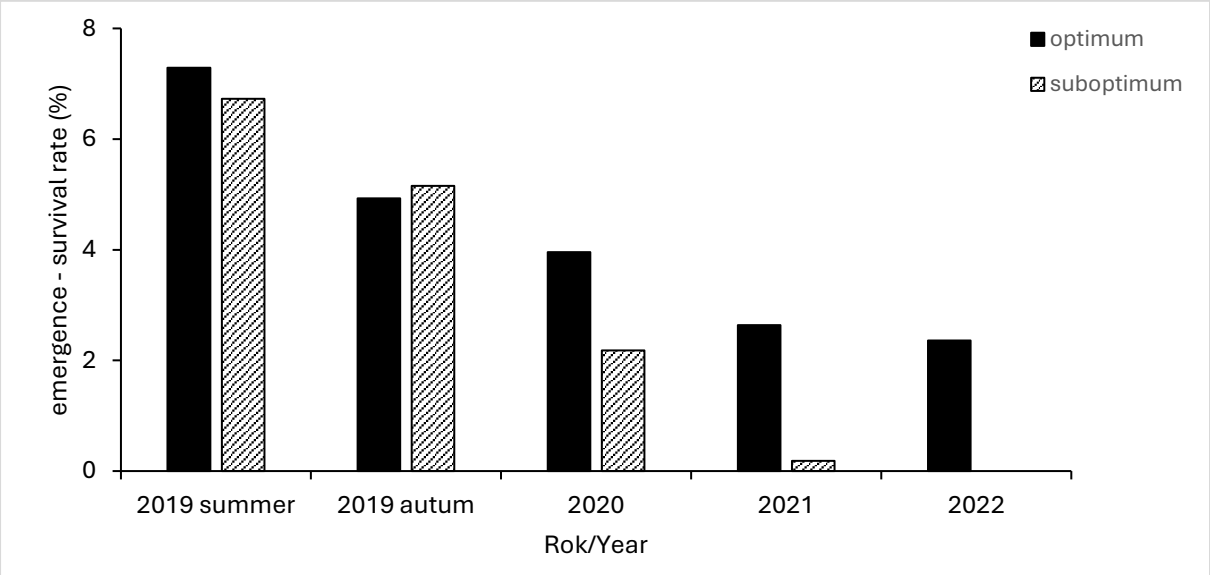

Fig 1. Emergence rate and survival rate of silver fir seed (seedlings); optimal site: fir-beech vegetation zone, suboptimal site: oak-beech vegetation zone.

To support the presumption that silver fir prospects well in pioneer stands, we analyzed the structure of naturally regenerated silver fir in 20 year old pioneer aspen-dominant stands, which emerged after Norway spruce dieback (Mokřinky, Padělky – Martiník, Krásenský 2023). The presence of mature silver fir around these stands led to spontaneous and continuous regeneration (Fig. 2).

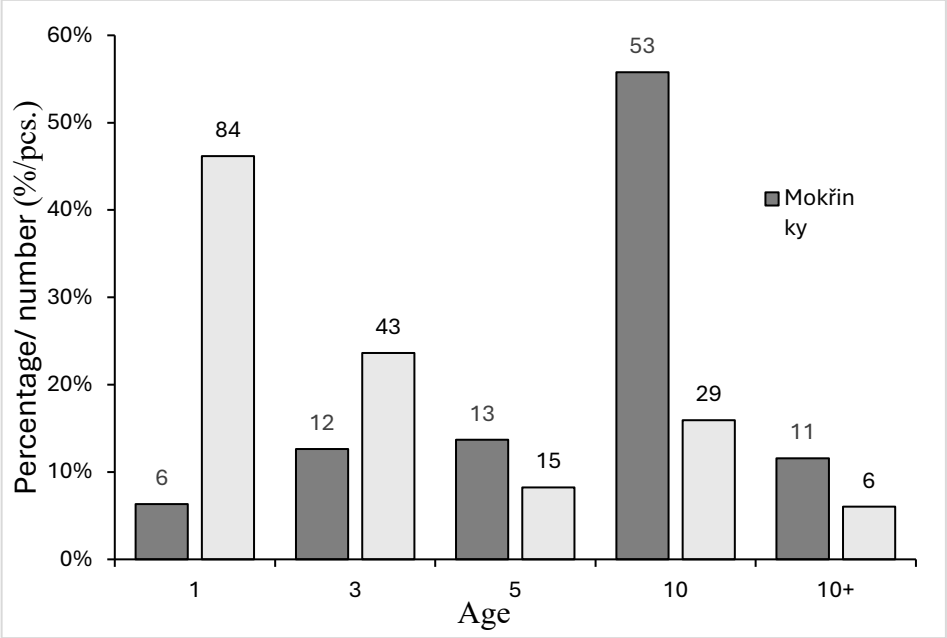

Fig. 2. Age structure of silver fir regeneration, growing in aspen pioneer stands (the numbers above the columns indicate the number of fir seedlings)

The timing of planting of silver fir relative to the age of the nurse crop was crucial. One approach considered planting the silver fir in row spacing with pioneer species immediately after clearing emergence, both species at the same time. In the second approach, silver fir was planted into preparatory pioneer stands of different ages and silvicultural regimes.

We found success in regeneration approaches, but only where soil moisture was sufficient (Tornádo). Pioneer stands stimulate early fast growth of silver fir, reduce seedling mortality and regeneration costs. At the same sites, silver fir planted without a mixture of pioneers was exposed to climatic extremes and weed competition. In clearings with a high level of soil moisture (Rakovec), direct planting of silver fir with (or without) pioneer was not successful (Martiník et al. 2018). On the site with sufficient soil moisture (Krnov), the pioneer height of about 4 m closed the canopy and covered silver fir with height of about 1 m after five years; thus, the stimulation effect of the pioneer stopped and started competition. To reduce competition for light and moisture frequent thinning is recommended (Fig. 3).

At water-affected soils (pseudogley - Stara Ves), the highest radial stem growth increment was recorded at the narrow gap (i.e. three rows of silver firs) but seedlings had to compete with grasses. Shelter of frequently thinned stand of silver birch suppressed the weed but still allowed high radial growth of silver fir. The dense unthinned canopy of silver birch suppressed the growth of both grass and silver fir. The photosynthesis of needles increased already the first year after thinning of the dense stand (Fig. 3). However, the increased carbon assimilation did not reflect in the stem radial growth, which remained in the first year after thinning same as in the dense stand (Fig. 4).

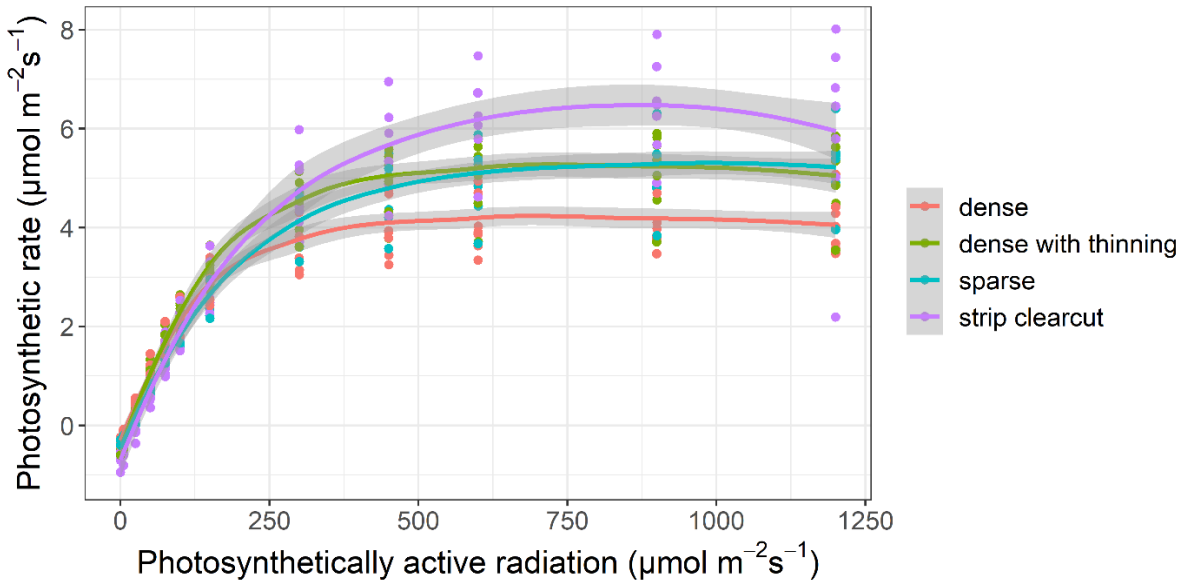

Fig. 3. Light response curves of Silver fir current year needles which developed under the birch canopy of different densities. Thinning of the dense overstory of formerly dense silver birch canopy resulted in the photosynthesis of new needles comparable to the one under a frequently thinned stand.

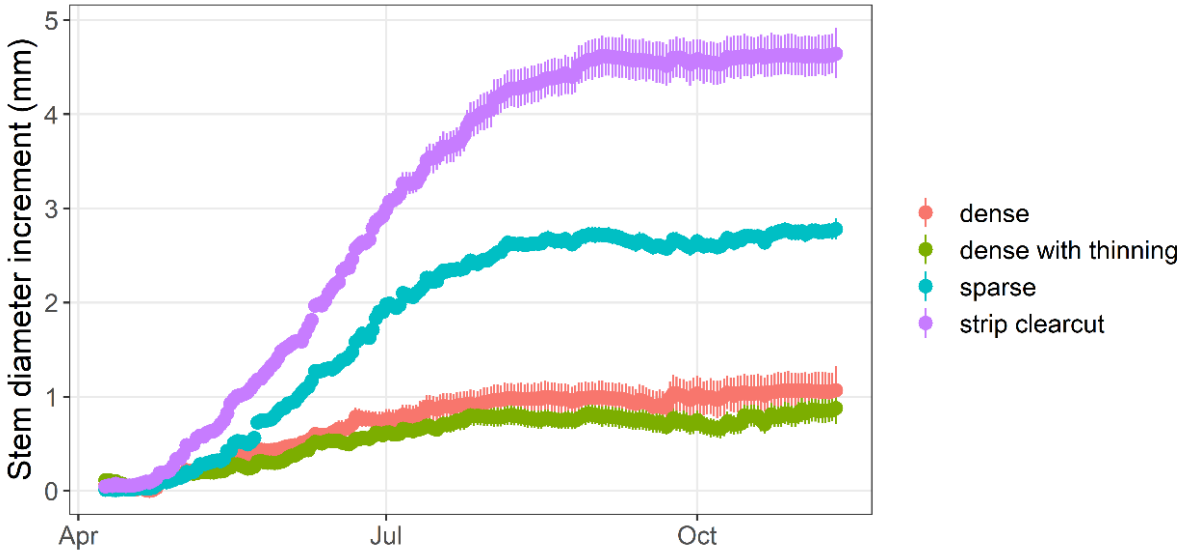

Fig. 4. Radial increment of silver fir plants growing under the shelter of sparse and dense birch, at a strip clearcut, and the response of silver fir that grew under the dense canopy to thinning.

The introduction of silver fir into preparatory (pioneer) stands optimizes structure of pioneer stands and reduces competition for light and moisture; to keep less cover of weeds and to balance the total forest ecosystem radial increment with pioneer trees included. At the suboptimal sites with drought-prone sites (Skrchov) the water stress of silver fir was evaluated. The silver fir was planted in different stands situations of about 20 years old silver birch stands: gaps (20x20 m), control no unthinned plots (density 3 000 trees per ha), strongly thinned plot (density 1 050 trees per ha). During summer drought, trees growing in the gap had the least

negative water potential, indicating no water stress (Fig. 5). On the contrary, both predawn and midday water potential of silver fir under the birch plummeted below -3 MPa, indicating the risk of drought-induced mortality (Nourtier et al. 2014). The water potential of birch was less negative than of the underplanted silver fir which indicates that deep roots can access water. Water stress and light availability jointly resulted in the highest height increment of Silver fir growth in the gap and lower under the tree canopy

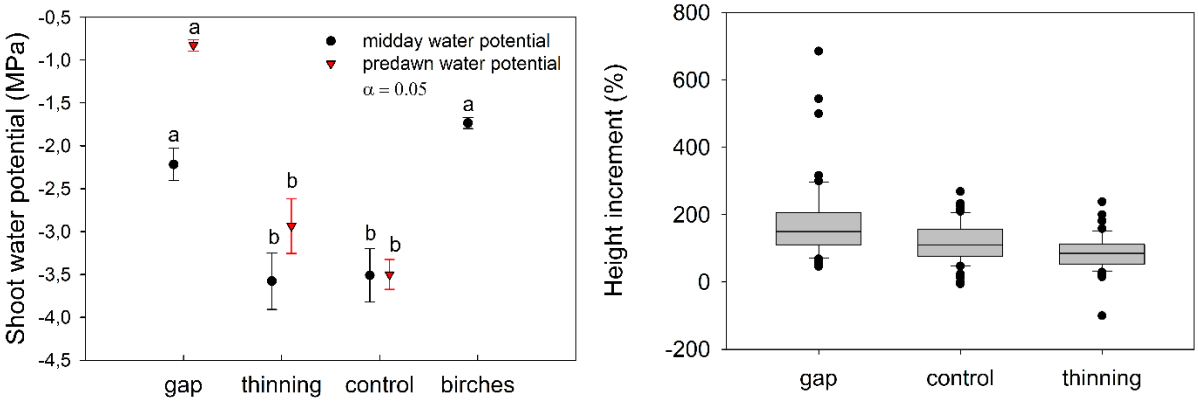

Fig. 5. Left: The water potential of the silver fir under the various densities of silver birch canopy and in the gap. Right: The height increment of the silver fir in the gap and under two densities of silver birch overstory.

Calamities and clearing may offer an opportunity to increase the proportion of silver fir in forest stands in the Czech Republic. Nurse crop methods, where fir is cultivated with the pioneers in variable time and space scale may provide a basic silvicultural tool for preservation and the increase of silver fir at exposed sites after large scale disturbances.

Acknowledgement

The work was supported by the project NAZV (QK22020008).

References

HUTH F., WEHNERT A., TIEBEL K., WAGNER S.. 2017: Direct seeding of silver fir (*Abies alba* Mill.) to convert Norway spruce (*Picea abies* L.) forests in Europe: A review. Forest Ecology and Management, 403: 61–78. DOI: 10.1016/j.foreco.2017.08.017

KORPEĽ Š., VINŠ B. 1964. Pestovanie jedle. Bratislava, Slovenské vydavateľstvo pôdohospodárskej literatúry: 340 s.

MARTINÍK A., SENDECKÝ M., URBAN J., 2018: Survival and early growth of pioneer species and silver fir within nursery crops regeneration systems in the region of central Europe. Dendrobiology, 81: 81–90.

MARTINÍK A., KRÁSENKSÝ J., 2023: Spontánní obnova jedle bělokoré pod porosty s převahou topolu osiky. ZLV, 68 (3): 126–136.

NOURTIER M, CHANZY A, CAILLERET M, YINGGE X, HUC R, DAVI H., 2014: Transpiration of silver fir (*Abies alba* Mill.) during and after drought in relation to soil properties in a Mediterranean mountain area. Ann For Sci 71: 683–695.

SPIECKER et al. 2004: Norway Spruce conversion. European Forest Research Reports. 269 p.

VOLAŘÍK D., HÉDL R. 2013. Expansion to abandoned agricultural land forms an integral part of silver fir dynamics. Forest Ecology and Management, 292: 39–48. DOI: 10.1016/j.foreco.2012.12.016

ZPRÁVA, 2021: Zpráva o stavu lesa a lesního hospodářství České republiky v roce 2021 [online]. Praha, Ministerstvo zemědělství ČR: 144 s. [cit. 2023-02-13]. Dostupné na: https://eagri.cz/public/web/mze/lesy/lesnictvi/zprava-o-stavu-lesa-a-lesniho/zprava-o-stavu-lesa-a-lesniho-2021.html