MENDEL UNIVERSITY IN BRNO

MENDELU
Faculty of Forestry
and Wood
Technology

Mendel
University
in Brno

Silva*Net* – Wood*Net* 2025

Proceedings Abstracts of Student Scientific Conference

Ing. Petr Čech
Ing. Kateřina Sedláčková
(eds.)

27 November 2025
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Proceedings Abstracts of Student Scientific Conference held
in Brno on November 27, 2025

Student Conference is organised by the Council of the Internal Grant Agency of the Faculty of Forestry and Wood Technology MENDELU under the patronage of the Dean of Faculty (Faculty of Forestry and Wood Technology MENDELU) Prof. Dr. Ing. Libor Jankovský and in cooperation with listed projects.

Specific University Research Activities of the Faculty of Forestry and Wood Technology MENDELU supported the conference.

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EVROPSKÁ UNIE
Evropské strukturální a investiční fondy
Operační program Výzkum, vývoj a vzdělávání

MINISTERSTVO ŠKOLSTVÍ, MLÁDEŽE A TĚLOVÝCHOVY

TENTO PROJEKT JE SPOLUFINANCOVÁN EVROPSKÝM FONDEM PRO REGIONÁLNÍ ROZVOJ

Výzkumné centrum pro studium patogenů z rodu *Phytophthora* CZ.02.1.01/0.0./0.0./15_003/0000453

Dotační titul: OP Výzkum, vývoj a vzdělávání
Výzva č. 02_15_003 pro Podporu excelentních výzkumných týmů v prioritní ose 1 OP
Doba řešení: 1. 12. 2016 – 30. 04. 2023
Příjemce projektu: Mendelova univerzita v Brně
Koordinátor projektu: prof. Dr. Ing. Libor Jankovský

Cílem projektu je vybudování komplexní infrastruktury a vytvoření mezinárodního, interdisciplinárního a multioborového výzkumného týmu se zaměřením na výzkum chorob dřevin rodu *Phytophthora*.
Aplikací a implementací inovativních technologií na bázi mikrobiologie, bioinformatiky, biologie, ekofyziologie, anatomie dřevin, genomiky a bioklimatologie, přispět k hlubšímu poznání faktorů ovlivňujících diverzitu, adaptaci a hybridizační procesy, které probíhají u rodu *Phytophthora*. Dále se pak zabývat evoluční historií tohoto rodu a molekulárními mechanizmy řídící náchylnost a odolnost dubů proti půdním patogenům tohoto rodu. Očekávané výsledky budou rozvíjet disciplínu fytopatologie dřevin, jako jednu z klíčových oblastí excelentního výzkumu na MENDELU, s pozitivními důsledky pro management a ochranu evropských ekosystémů. Bude prohlubována stávající mezinárodní spolupráce s předními světovými institucemi, s cílem a ambicí založit a udržet vzniklý mezinárodní tým VaV centra MENDELU, jako lídra v oboru a získat navazující projekty mezinárodní spolupráce ve výzkumu chorob dřevin rodu *Phytophthora*. V rámci projektu byla doplněna stávající infrastruktura laboratoří VaV MENDELU o špičkové přístroje a vybavení bezprostředně související s výzkumem chorob dřevin zapříčiněných parazity rodu *Phytophthora*.

Partneři projektu:

- Austrian Research and Training Centre for Forests, Natural Hazards and Landscape
- Svaz školkařů České republiky, z. s.
- Arboeko s.r.o.

Phytophthora Research Centre

ARBOEKO

BFW

http://www.phytophthora.org

ERA-Chair: Striving for Excellence in the Forest Ecosystem

The project "ERA-Chair: Striving for Excellence in the Forest Ecosystem" (EXCELLENTIA) brings new insights into the issue of climate-threatened forest ecosystems in Central Europe concerning the needs of society but also sheds light on how much man has contributed to past instability by moving away from the cultivation of natural forests towards monocultures. EXCELLENTIA builds on the availability of data and the research programme already underway at the Faculty of Forestry and Wood Technology MENDELU. The necessary data collection and practical analysis are also conducted at the University Forest Enterprise Masaryk Forest Křtiny.

A cutting-edge interdisciplinary research group is established under the Faculty of Forestry and Wood Technology to research forest ecosystems under the leadership of leading scientist Professor Douglas L. Godbold. The multidisciplinary team of researchers investigate the sustainability of forest ecosystem functions in the context of the ongoing climate change and ensures forest stability for the coming decades. Drought, tree species responding differently to drought, and the susceptibility or resistance of tree root systems to pathogen attack are other issues the project addresses.

In addition to the scientific line, the EXCELLENTIA project aims to bring about structural changes in sustainable research and innovation, intellectual property rights and research data management, codification of scientific ethics and career guidance. Training activities aimed at young researchers and supervision of BSc, MSc and PhD theses are also part of the projects. Through Professor Godbold's exceptional contacts within the European scientific community, the team is envisaged to be involved in major international projects.

The results of the project are continuously communicated not only to the professional but also to the general public. The project also envisages cooperation at the level of secondary schools.

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@EXCELLENTIA_HE
https://excellentia.ldf.mendelu.cz/

Funded by the European Union

EXCELLENTIA
Forest Ecosystem Research

This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement N°101087262.

LECA - CE0100170 – Supporting the coexistence and conservation of Carpathian LargE Carnivores

Duration: 1. 4. 2023 – 31. 3. 2026

Lead partner: Mendel University in Brno

Project coordinator: Mgr. Martin Duľa, Ph.D.

Project partners: WWF Poland, WWF Slovakia, WWF Hungary, Technical University in Zovlen, Bükk National Park Directorate, Tatra National Park, State Nature Conservancy of the Slovak Republic, Friends of the Earth Czech Republic Carnivore Conservation Programme, Ministry of the Environment of the Czech Republic, Zarand Association, Slovenian Forest Service

Large carnivores are key components of forest ecosystems in the Carpathians, hosting one of the most abundant native populations of lynx, wolf and bear in Europe. However, whether populations are stable or growing is unclear as data are not collected harmoniously across borders. There are no shared regulations and policies on large carnivore's conservation (e.g. poaching prevention) and no shared understanding and coordination between stakeholders. Clear is, however, that perceived and actual conflicts between humans and large carnivores are on the rise. To promote coexistence with local stakeholders, to enable viable large carnivores population structures, natural expansion and recolonisation of large carnivores, to establish evidence-based and coordinated practices in the Carpathian countries, and to contravene misconceptions, LECA wants to raise awareness, educate, engage and influence target groups such as hunters, foresters, farmers, livestock and beekeepers, police investigators (poaching), ministries, municipalities and the broad public.
The project aims are (1) a consistent and efficient monitoring approach involving local stakeholders; (2) up-to-date population information in cross-border regions; (3) effective conflict prevention measures to be rolled out at the Carpathian level; and (4) improved participative cooperation of key actors at local, regional and transnational level. A Thematic Guidance on large carnivore's conservation and coexistence in the Carpathians will be created and validated via pilot actions in cross-border pilots (Tatras (SK/PL), East Carpathians (SK/PL/UA), Slovak Karst - North HU Mountains (SK/HU), Beskydy-Kysuce (CZ/SK) and reference areas (SL/RO), driving pilot area strategies, national recommendations and an IT app for the public. The Guidance will cover novel, unified tools for harmonised Monitoring, Poaching investigation and Conflict prevention.
The three-year LECA project is funded by the EU Interreg Central Europe programme.
More information: https://www.interreg-central.eu/projects/leca/

Plant pest prevention through technology-guided monitoring and site-specific control

PurPest aims to control serious plant pests during import and manage pests in the field by enabling pest detection in a timely and non-invasive manner. The PurPest concept will exploit the specific volatiles released by pests or pest-infested plants to develop a sensor system prototype (SSP) that detects the presence of these pests during plant import and monitors pests already present in Europe. Implementing the PurPest concept is expected to drastically decrease the risk of new pest invasions in Europe and optimise pesticide use, where and when necessary. Additionally, the PurPest concept used in nurseries to detect serious pests will significantly reduce the distribution of pest-infested plant material between exporting and importing countries and their further spread within these countries. PurPest will involve all stakeholders along the value chain in a multi-actor approach to promote this concept, including plant health officers, nursery representatives and forest organisations.

PurPest focuses on five diverse pests in forestry, horticulture and agriculture: the forestry pathogen causing Sudden Oak Death, Phytophthora ramorum, the causal agent of Pine Wilt Disease, Bursaphelenchus xylophilus, the Cotton Bollworm, Helicoverpa armigera, the Brown Marmorated Stinkbug, Halyomorpha halys and the EU A1 listed Fall Armyworm, Spodoptera frugiperda. Current detection technology is being optimised and implemented in the SSP. Using this detection tool to screen plants and wood-based packaging material during import will allow us to detect incoming pests, destroy any infected material and prevent the target pests from entering the EU and associated countries. These actions will be supported by developing policy recommendations in collaboration with the industry stakeholders, the plant pest scientists and legislators from the national plant protection organisations to ensure the feasibility, economic and ecological benefits and high efficiency of this screening method. The detection concept developed, validated and demonstrated in PurPest, and supported by appropriated policy recommendations will effectively respond to EU quarantine and other serious plant pests threatening European agriculture, horticulture and forestry.

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Funded by the European Union

This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement N°101060634.

ForDiL: Forest of the future: digital tools for learners to foster CCF

Since the launch of ForDiL, the project has gained momentum through several fruitful exchanges between partners and students. In April 2024, the Technical Horticultural Institute of Gembloux (ITHCF) in Belgium hosted French and Czech students for a week of exchanges and practical workshops focused on Continuous Cover Forestry (CCF). This event allowed participants to delve into CCF concepts and confront them with real-world field conditions while encouraging dialogue among young learners from different countries.

In May 2024, the project team gathered at Mendel University in Brno for an international meeting. This working session allowed the team to finalise the implementation protocol for the Marteloscope-Travailloscope field tool at the core of the ForDiL project. Marteloscopes and travailloscopes are silvicultural training sites, usually one hectare, in which all trees are numbered, mapped and recorded. Based on this data, a software program guides and evaluates the learner's tree felling/conservation choices. A travailloscope works on the same basic model but aims to test the results of different silvicultural operations and the impacts (economic, ecological) favourable or unfavourable to irregular stand management. Currently, partners focus on the designation and set-up in France, Belgium, and the Czech Republic.

In October 2024, the ForDiL team met again at the UFA in Bavay, France, to mark out the continuation of the project. The next major milestone, scheduled for 2025, will be developing the digital application linked to the Marteloscopes-Travailloscopes. This will make this forestry management approach even more accessible to learners and forest managers.

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Co-funded by the European Union

Strategies for Conservation of narrow-leaved ash (*Fraxinus angustifolia*) in the Danube basin (SCAN-DANUBE) – DRP0300848

Duration: 01.04. 2025 – 31.03. 2028
Lead partner: Mendel University in Brno
Project coordinator: Mgr. Alena Šamonilová

The SCAN-DANUBE project deals with narrow-leaved ash (*Fraxinus angustifolia*), a stand composing tree species native to alluvial forests of Central and South Europe, where it plays a crucial role in the ecosystems of the Danube region, offering ecological, economic, and social benefits. The species is endangered by unsustainable human activities and climate change issues, such as extreme temperatures, shifts in precipitation patterns and fluctuating water tables throughout the year, by invasive pathogens (e.g. *Hymenoscyphus fraxineus*) and by a frequently observed loss of natural reproduction. Considering the lack of guidance on how to manage these forests, a significant decrease in abundance of narrow-leaved ash can be expected in near future with consequent economic losses, destabilization of stands and loss of alluvial forests biodiversity. Having this in mind, a coordinated international approach is needed to enhance the resilience of narrow-leaved ash forest resources and ecosystem services in the Danube region, with a strong emphasis on sustainable forest management and conservation of this species genetic resources.
Therefore, overall objective of SCAN-DANUBE is to counteract narrow-leaved ash forests decline in the Danube region by providing novel strategies and guidelines for forest management and conservation of this tree species in both commercially used and protected alluvial forests of the Danube area. The SCAN-DANUBE consortium consists of 6 project partners and 9 associated partners from Austria, Bosnia and Herzegovina, Croatia, Czech Republic, Serbia and Slovenia, geographically covering the largest part of the natural distribution of narrow-leaved ash in the Danube region, and is led by the Mendel University in Brno.

Project partners:

- Austrian Research Centre for Forests
- Slovenian Forestry Institute
- University of Zagreb Faculty of Forestry and Wood Technology
- University of Banja Luka
- Institute of Lowland Forestry and Environment

Contact: Mgr. Alena Šamonilová, alena.samonilova@mendelu.cz

SMARTbeetle - ATCZ158 – Using AI and Molecular Scent Profiling for Species-Specific and Eco-Friendly Spruce Bark Beetle (Ips typographus) Control

The SMARTbeetle project has two main objectives:

- to develop more effective and specific attractants for monitoring and control spruce bark beetle using modern biological and information technologies and to verify their effectiveness in the field
- to create a universal methodology for the development of odorous attractants effective against olfactory-oriented pests using the spruce bark beetle model

Bark beetle outbreaks represent a constant threat to spruce stands, which may further grow due to climate change. In the last few years, large-scale deforestation has occurred across much of Central Europe, which has disrupted all forest functions.

The goal of the SMARTbeetle project chooses to improve the effectiveness of lure attractants in pheromone traps. The combination of modern biological methods and artificial intelligence (AI) allows the design of an entire mixture of substances optimized for a specific species (the spruce bark beetle). This should significantly increase the efficiency of trapping while minimizing the risks of affecting non-target species. This measure will stop or slow down population growth of the bark beetle and contribute to a lower use of pesticides. In the conditions of ongoing climate change, this means more time to transform forests into a form more suited to current environmental conditions.

Another important contribution of the project will be the method of attractant development. It will be a universal and publicly available methodology that can be used for the development of other attractants – specific mixtures of substances effective on any organism that navigates by smell (incl. invasive species).

The SMARTbeetle project objectives require specific knowledge in several areas. Therefore, a seven-member consortium was formed, covering all specializations necessary to meet the project objectives. Most of the necessary methods have already been mastered by the consortium and will be adapted to bark beetles. The most promising attractants will be verified in field tests.

A number of forest owners, managers, state administration and forestry companies have expressed interest in the project. It is therefore perceived as a promising contribution to solving the large-scale forest dieback.

Duration: 1. 12. 2024 – 30. 11. 2028

Project partners: Software Competence Center Hagenberg GmbH (leading partner); Business Upper Austria Ltd.; Forestry and Game Management Research Institute; Mendel University in Brno; Technical University Vienna; University of Applied Sciences Upper Austria; University of South Bohemia in České Budějovice

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Forest Protection, Wildlife Management, Forest Phytology and Forest Ecology

FLOWERING STRIPS AS A TOOL TO SUPPORT PINE NURSERY HEALTH: EFFECTS ON ARTHROPOD COMMUNITIES AND TREE PERFORMANCE

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Keywords: biological control, habitat complexity, herbivory, spiders, tree physiological vitality

1 INTRODUCTION

The modern European landscape is profoundly impacted by the widespread use of pesticides for plant protection, leading to various negative effects on ecosystems (Raven & Wagner, 2021) and human health (Kim et al., 2017). Reducing of pesticide use has thus become essential to mitigate these risks. One promising possibility is conservation biological control (CBC), which involves supporting natural predators through various habitat management to suppress pest populations (Holland et al., 2016). Numerous studies have already showed that increasing habitat heterogeneity lead to an increased number of natural enemies (Birkhofer et al., 2022) that play a crucial role in controlling insect pests across the globe (Boldorini et al., 2024). The increase in habitat heterogeneity can be achieved through various strategies such as establishment of flowering strips (FSs) (Krahner et al., 2024) FSs enhance the activity and persistence of natural predators by creating structurally complex habitats that supply alternative prey and floral resources crucial for predator reproduction, development, and overwintering (Gardarin, 2023). However, it is still unclear whether increased predator densities will cascade down to enhance tree vitality, as various buffering mechanisms may prevent such effects (Garfinkel et al., 2022; Mayne et al., 2023).

Although benefits of FSs have been quite widely studied in agroecosystems (Alarcon-Segura et al., 2025; Durak et al., 2025), there is a lack of research on their role in woody plant nurseries, particularly regarding how they influence arthropod community composition and tree physiological vitality including photosynthesis efficiency, which is based of tree grow. Nevertheless, tree nurseries are usually managed very intensively with large doses of pesticides (Leroy, 2024). Therefore, this management needs to by also changed and introducing of FSs could be a suitable pest management method in this kind of habitats.

2 MATERIALS AND METHODS

In this study, conducted in the ornamental and forest nursery, we therefore compared tree physiological vitality indicators and arthropod communities between plots with FSs established in the interrows and control plots without FSs, to determine whether FSs are suitable for use in tree nurseries. Tree vitality was evaluated using chosen vitality indicators, including quantifying herbivory–dry needle biomass and needle damage percentage, measuring of SPAD (relative chlorophyll content) and chlorophyll fluorescence-based parameter NPQt (non-photochemical quenching). Arthropods

were sampled by beating method, identified in laboratory and analysed on abundance levels.

3 RESULTS

We found that dry needle biomass was significantly higher in trees with FSs established in the interrows, while the percentage of needle damage was lower in these trees compared to trees without FSs. The SPAD index was also higher in needles of trees adjacent to FSs. Similarly, the NPQt parameter indicated that trees with FSs were less stressed, showing lower NPQt values than control trees. The analysis of invertebrate abundance revealed that pine canopies in the presence of FSs contained more predators, fewer herbivores, and fewer omnivores (specifically ants) than on the pines without FSs. Our results therefore demonstrate FSs in interrows significantly increase the abundance of predators, leading to a reduction in herbivores and indirectly improving the physiological vitality of trees.

These findings suggest that integrating FSs into pine nursery management can strengthen biological control services, reduce pest pressure, and promote the growth and health of young trees.

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EFFECTS OF HABITAT MANIPULATIONS ON TROPHIC CASCADES IN ORNAMENTAL PINE NURSERIES – PRELIMINARY RESULTS

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Keywords: biological control, birds, habitat management, natural enemies, pest, spiders

1 INTRODUCTION

The modern European landscape faces significant ecological challenges due to the widespread use of pesticides, leading to various adverse effects both on ecosystems and human health (Bernhardt et al., 2017; Kim et al., 2017). Promising alternative to pesticides is conservation biological control (CBC), an approach that reduces pest populations by enhancing the habitats and presence of natural predators (Wyckhuys et al., 2013). By strengthening predator populations, CBC aims to harness trophic cascades to suppress pests and support plant vitality (Sam et al., 2023; Sivault et al., 2024). Numerous studies have demonstrated that increasing habitat heterogeneity through various habitat management practices leads to a higher abundance of naturally occurring predators (Birkhofer et al., 2022) and can reduce intraguild predation (IGP) – situation when predators prey on each other and thus potentially reduce the overall predation pressure on pests (Staudacher et al., 2018). Habitat heterogeneity can be enhanced through strategies such as the establishment of flowering strips (FSs) (Krahner et al., 2024) or the installation of alternative shelters for invertebrate predators (e.g., cardboard bands on trees) (Korenko & Pekár, 2010). However, there is still a lack of studies focusing on the synergistic effects of multiple predators on pest suppression, particularly regarding their impact on plant vitality, which is essential for production system managers to support the practical implementation of CBC within pest management frameworks.

2 MATERIALS AND METHODS

Using manipulative field experiments, we investigated the effects of vertebrate (birds and bats) and arthropod predators on pest populations and overall pine tree vitality– measured through needle biomass, needle damage, relative chlorophyll content, and chlorophyll fluorescence parameters–within ornamental and forest tree nurseries. Management in such production systems is typically intensive and heavily reliant on pesticide use (Leroy, 2024). Therefore, implementing CBC practices is essential to reduce the negative environmental impacts associated with intensive management. In this study, we established eight independent plots, each consisting of a single row of pine trees: four with FSs planted in the interrows and four without, enabling a direct comparison between the two management strategies. Vertebrate predators were excluded using cages with netting installed around selected trees, while arthropod predator abundance was enhanced by placing cardboard bands on designated trees.

3 RESULTS

Preliminary results indicate that needle biomass was significantly higher in pines with FSs in the interrows than in those without. Needle biomass also varied among experimental treatments: the highest values were recorded in trees with both

cardboard bands and bird and bat exclusion, while control trees showed the lowest biomass. The percentage of needle damage was highest in trees without FSs and was significantly greater in control trees compared to manipulated ones. The lowest needle damage occurred in trees with the combination of cardboard bands and bird and bat exclusion.

These findings suggest that FSs improve the physiological condition of pine needles. Because herbivory was lowest in trees with both cardboard bands and bird and bat exclusion, it is likely that invertebrate predators, particularly spiders, played a stronger role in biological control and that habitat manipulation helped to reduce IGP. Analyses of SPAD values, chlorophyll fluorescence parameters, and arthropod abundance are still ongoing. Nevertheless, based on the preliminary results, we suggest that FSs may serve as an effective CBC measure in tree nurseries, with their efficiency further enhanced by the use of cardboard bands to mitigate IGP.

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BENEATH THE TRACK: EFFECTS OF FOREST HARVESTING AND WOOD RETENTION ON BELOWGROUND ECOSYSTEM FUNCTIONS

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Keywords: fine root biomass, salvage logging, soil disturbance

1 INTRODUCTION

Fine roots play a crucial role in forest ecosystems by absorbing water and nutrients, and contributing significantly to soil organic matter and carbon cycling (Finér et al., 2011). While the impact of regular harvesting operations involving heavy machine traffic is increasingly studied - mechanical traffic disturbs soil, increasing bulk density and mechanical impedance, which damages fine roots and impairs their capacity to proliferate and access resources (Latterini et al., 2024) - the effect of different management options following windthrows on roots and their mycorrhizal symbionts has not yet received substantial attention.

2 MATERIALS AND METHODS

In this study, we used the windthrow that occured in June 2024, scattered across the University Forest Enterprise area. By merging remote sensing data and field inspections in a regionalization approach, we selected three research areas and installed four treatments in each: (i) Control: intact forest, (ii) Stem: no salvage logging, (iii) Branch: salvage logging, branches retained, and (iv) Leaf: salvage logging, only leaves retained. On each of the 12 plots, we took soil samples at different depths and used them for analysing (extended) fine root traits as well as soil physical properties.

3 RESULTS

Overall, we found 1.18 ± 1.37 mg/cm³ of fine roots, clearly dominated by the abundance of fine roots in the organic layer (1.61 ± 1.60 mg/cm³) and the mineral topsoil (1.41 ± 1.49 mg/cm³). Fine root biomass decreased with soil depth, to 0.500 ± 0.390 mg/cm³ in 20–30 cm ($p < 0.01$).

Interestingly, the treatments had already a significant influence on fine root biomass ~ half a year after disturbance. While the relative density of fine roots was high in the stem and branch plots (1.18 ± 1.21 mg/cm³ and 1.27 ± 1.52 mg/cm³, respectively), the salvaged and completely cleared leaf plots possessed a lower fine root content (0.700 ± 0.850 mg/cm³). Compared to the control (1.86 ± 1.65 mg/cm³), all treatments resulted in a clear decrease in fine root biomass, yet stronger reductions occurred with higher intensity of the management option ($p < 0.001$). We attribute this change to the severity of soil disturbance. Accordingly, the amount of fine root necromass clearly responded to soil bulk density, which was increased by extensive

machine traffic on leaf and branch sites. Additional analyses integrating the effects of microclimatic and biogeochemical stocks, as well as microbial biodiversity, over time since the disturbance will follow.

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ACKNOWLEDGEMENT

This study was supported with funding provided by the Internal Grant Agency, Mendel University in Brno, project number IGA25-FFWT-TP-003.

EFFECT OF PRUNING DURING PLANTING ON TREE PHYSIOLOGY AND GROWTH

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Keywords: bare-rooted tree material, hornbeam, pedunculate oak, transplanting

1 INTRODUCTION

Tree transplanting is associated with many stress factors that negatively affect its subsequent establishment and growth. With harvesting of the bare-rooted or balled and burlapped trees is necessarily associated with the loss of part of the root system. Currently, there is no unified opinion on the application of tree pruning when planting them in a permanent habitat. Proponents of the application of pruning support its usefulness with the argument of maintaining a balance between the root system and the above-ground parts of the tree (Gilman, 2012; Kozlowski, Davies, 1975; Watson, 1991).

Opponents of the application of the pruning argue the loss of auxin located in the top parts of the tree crown, which are partially removed by the pruning. This loss is another stressor because auxin promotes the growth of lateral roots. When it is lost, the growth of lateral roots is limited (Watson, 2014; Watson, Himelick, 2013; Whitcomb, 1987).

Another factor is the increasing stress load caused by high temperatures and radiation in the current climate change. With current domestic values, there is practically no experience with current conditions (Ruehr et al., 2019), and recommended technological procedures for tree planting can quickly lose their validity (Levinsson, Fransson, Emilsson, 2017).

2 MATERIALS AND METHODS

The aim was to compare the response of the bare-rooted trees to the pruning made when planting on a permanent site. It is a comparison of the reaction of individuals who were pruned with individuals who were left without a pruning. Two broadleaved tree species were examined: three years old hornbeam plants and two years old pedunculate oak plants.

Experiment was conducted from early spring to late September. The experiment was conducted in parallel at two locations: Libouchec (North Bohemia, altitude 320 m, part of the orchard) and Řečkovice (South Moravia, altitude 300 m, training forest tree nursery). On each location were used from each tree species 15 plants as treatment group and 10 plants as control group (i.e. Libouchec 2 × (15 + 10) trees and Řečkovice 2 × (15 + 10) trees).

An equal portion of the roots was removed from all plants to simulate root loss during transplanting. All plants were planted in plastic containers of the same size and form. Ten control trees were planted without pruning. Treatment groups were pruned with different intensity (with an estimate of tens of percent).

All plants were watered with the same amount of water throughout the experiment. All containers with trees were placed in larger containers to prevent roots growing into the ground and to reduce heating of the sides of the smaller plant containers with trees.

Containers with trees were placed in four rows at equal intervals. In the individual rows, the species of the examined tree were alternate regularly.
Water potential was measured using a Scholander pressure chamber PMS 100 (PMS INSTRUMENT COMPANY, ALBANY, OR, USA), photosynthesis and stomatal conductance using a LI-6800 instrument (LICOR, LINCOLN, NEBRASKA, USA) and non-photochemical quenching, linear electron flow using a MultispeQ 2.0. instrument (PHOTOSYNQ INC., EAST LANSING, MI, USA).
Biometric data were measured: intensity of pruning, trunk diameter (at the beginning of the experiment); leaf area (during the experiment); trunk diameter, average length increment. Dry mass was determined divided trees at five groups: leaves, current year shoots, older shoots and trunk, thick roots, thin roots at the end of the experiment. Meteostation Minikin RTHi/QTHi (EMS, BRNO, ČR) with dataloger and precipitation gauge Minikin ERi (EMS, BRNO, ČR) were installed in Libouchec. Data from permanent meteostation (AMET, MORAVSKÝ ŽIŽKOV, ČR) were used in Řečkovice. Dendrometers (EMS, BRNO, ČR) and soil moisture datalogers (TOMST, PRAHA, ČR) were installed on a third of the trees in Řečkovice.

3 RESULTS

Preliminary results suggest that pruning during planting has a greater impact on subsequent growth and morphology than on tree physiology. More significant differences in morphology and growth were found in hornbeam than in pedunculate oak.

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ADAPTATION OF NORWAY SPRUCE MANAGEMENT TO CLIMATE CHANGE BY CHANGING THE INTENSITY OF THINNING

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Keywords: dendrometers, drought, tree growth, tree ontogeny, water potential

1 INTRODUCTION

Episodes of widespread tree mortality due to drought stress are increasingly observed worldwide (e.g. Anderegg et al., 2016), and climate models predict more frequent and severe droughts (IPCC, 2014). These changes threaten forest health, potentially increasing mortality, altering species composition, and reducing carbon sequestration (Allen et al., 2010). Forest management strategies to mitigate drought impacts include adjusting stand structure and promoting adaptive traits (D'Amato et al., 2013). One widely recommended approach is thinning, which reduces tree density to enhance resource availability for remaining trees. Thinning has been shown to improve soil water availability and reduce climate stress through lower transpiration and canopy interception (Moreau et al., 2022). It may also promote deeper root development (Misson et al., 2003). However, thinning effects vary with intensity and may diminish over time (Duursma, 2011). Despite its popularity, long-term empirical evidence remains limited (Erdozain et al., 2023). The objective of this article is to assess the effects of different thinning intensities of young Norway spruce (*Picea abies* [L.] Karst.) stand.

2 MATERIALS AND METHODS

The study was conducted at the School Forest Enterprise Křtiny, CZ (51° 55′ 55.2″ N and 18° 12′ 50.4″ E) during 2022–2024 season. At the selected site, thinning was carried out at two intensities in year 2022: 1) light (removal of 20% of trees) and 2) heavy (removal of 50% of trees). At the same time, part of the stand was remained untreated (i.e., control area). Subsequently, 10 trees were selected in each plot for detailed daily and annual tree growth monitoring by automatic point dendrometer D2 (Tomst Ltd., Czechia). In each plot microclimate changes were determined using TMS-4 sensors (Tomst Ltd., Czechia) that measure both air and soil temperature along with soil moisture, Four TMS-4 sensors were installed in each plot.

3 RESULTS AND DISCUSSION

Non-thinned plots had the lowest soil moisture availability (around 35%) (Fig. 1). Light thinning increased soil moisture by 74%, reaching approximately 61%, while heavy thinning resulted in a 96% increase, bringing availability close to 69% (Fig. 1). This confirms that thinning substantially improves water availability, with heavy thinning providing the greatest benefit, likely due to reduced stand transpiration and canopy interception. Non-thinned plots showed the smallest radial growth (about 6 mm). Light thinning increased growth by 34%, whereas heavy thinning boosted growth by 199% (Fig. 1). This dramatic improvement under heavy thinning suggests that reduced competition for resources strongly enhances tree vitality and growth potential. Non-thinned plots experienced the highest drought stress (around 75%). Light thinning reduced stress by 26%, lowering it to roughly 55%, while heavy thinning decreased

stress by 96%, reducing it to only 3% (Fig. 1). This indicates that heavy thinning is highly effective in mitigating drought stress, almost eliminating its impact compared to non-thinned stands.
In conclusion, these findings support heavy thinning as a powerful strategy for enhancing drought resilience in young Norway spruce stands.

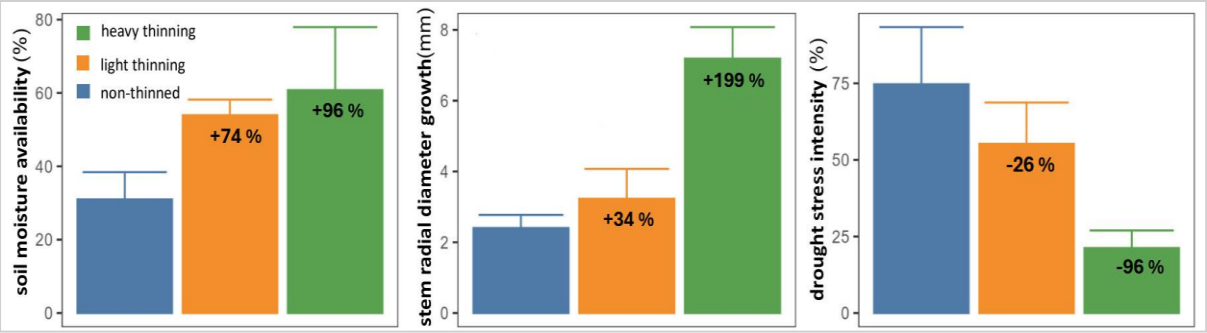

Fig. 1: Overall effect of different thinning intensities on the soil moisture availability, stem radial diameter growth and drought stress intensity in the young Norway spruce stand during a period 2022–2024

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THE INFLUENCE OF STAND AGE STRUCTURE ON SOIL MOISTURE ACROSS THE SOIL DEPTH GRADIENT

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Keywords: absorption zones, beech, mineral horizon, organic horizon, special purpose forest

1 INTRODUCTION

We focused on evaluating various soil properties across four developmental stages of forest stands to understand how the distribution of soil moisture within the soil profile varies with forest stand age. The primary objective was to determine the extent to which forest developmental stages affect soil moisture dynamics. In this research, attention was focused exclusively on bulk soil moisture (BulkMoist, Theta – Θ), which, in contrast to gravimetric moisture content (w), more accurately represents the physiologically available water regime in the forest stand. Statistically significant differences in soil gravimetric moisture were observed not only among the individual developmental stages but also across the various soil horizons. The results indicate that forest developmental stage strongly structures the vertical distribution of available water, likely reflecting differences in stand structure, rooting depth, and organic matter inputs.

2 MATERIALS AND METHODS

The research plots were established in the University enterprise Masaryk Forest in Křtiny. Four research plots (16 × 16 m) were selected, representing stands aged 40, 60, and 123 years, as well as uneven-aged European beech (*Fagus sylvatica*) stand. At each site, a geodesic grid with 1 × 1 m was established to facilitate systematic soil sampling. Soil sampling was carried out at regular 2 meters intervals at various depths (10–60 cm). At each depth, both volumetric (Θ) and gravimetric (w) soil moisture were measured. Measurements were conducted in spring over a period of five consecutive rain-free days to minimize the influence of recent precipitation events. Subsequently, soil samples from each layer were collected for laboratory analysis. The measured data were subjected to statistical evaluation, with all tests performed at a significance level of $\alpha = 0.05$.

3 RESULTS

3.1 BULK SOIL MOISTURE CONTENT WITHIN EUROPEAN BEECH (*FAGUS SYLVATICA*) STANDS

Statistically significant differences in soil moisture were observed not only among the various forest developmental stages but also across distinct soil horizons. The influence of developmental stage on soil moisture was non-linear; at certain depths, the uneven-aged stand exhibited higher moisture values than the mature stand, whereas in other layers the opposite pattern was observed.

3.2 BULK SOIL MOISTURE CONTENT WITHIN THE GRID-BASED ANALYSIS OF THE ENTIRE PROFILE AND AT 10 CM DEPTH

Grid-based analyses confirmed consistent differences among developmental stages, particularly in the surface soil layers, where moisture is most susceptible to variation. The lowest moisture levels were observed primarily in the structurally complex stands, probably resulting from pronounced vertical distribution of rooting, not only in the surface soil layers but throughout the entire profile.

3.3 SOIL pH WITHIN BEECH STANDS

The values of pH in older beech stands were slightly lower, indicating a mild acidification associated with long-term litter accumulation. The trend suggests that stand aging leads to gradual acidification of the upper soil horizons, while pH increases with depth.

3.4 TOTAL ORGANIC CARBON (TOC) WITHIN BEECH STANDS

The organic carbon content increases with stand age and volume, as litter production rises and humus accumulation intensifies over time. Younger beech stands exhibit lower total organic carbon, reflecting faster decomposition rates and a smaller organic matter reservoir. Overall, older forest stands serve as a more significant pool of soil organic carbon, with TOC values gradually decreasing with depth in all cases.

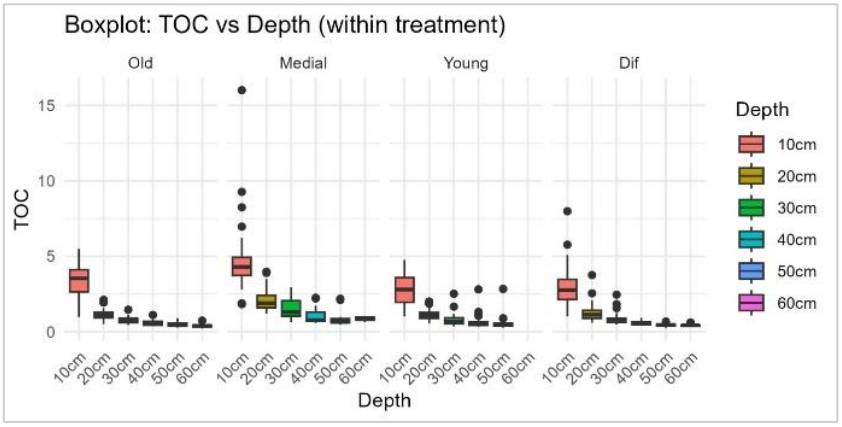

Fig. 1: Total organic carbon vs Depth (within treatment)

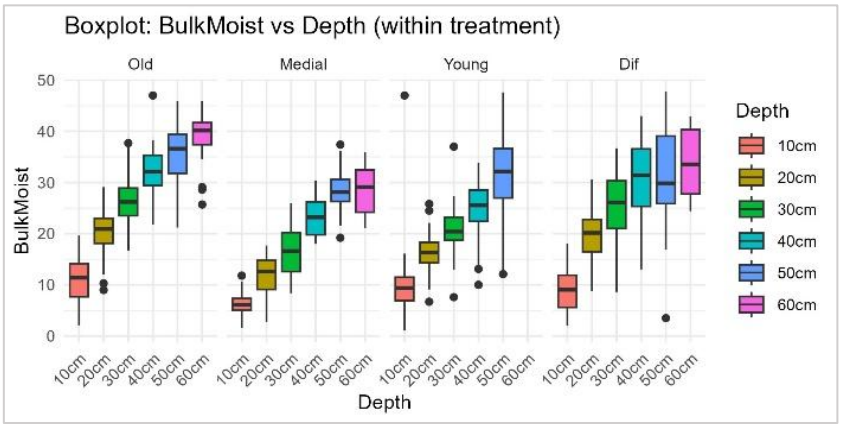

Fig. 2: BulkMoist vs Depth (within treatment)

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The study was supported with funding provided by the Internal Grant Agency, Mendel University in Brno, project number IGA-FFWT-23-TP-010.

EFFECT OF ORGANIC SUPERABSORBENT ON THE GROWTH OF *BOSWELLIA SOCOTRANA SUBSP. APLENIIFOLIA* ON SOCOTRA ISLAND

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Keywords: biodiversity preservation, drought adaptation, soil moisture retention

1 INTRODUCTION

As drought frequency and severity intensify due to climate change, innovative strategies are increasingly critical for preserving and restoring indigenous plant species in natural ecosystems. This study evaluates the effectiveness of superabsorbent polymers (SAPs) on Socotra, Yemen, focusing on their potential to mitigate water scarcity. Socotra experiences highly erratic rainfall, resulting in dry conditions for most of the year. The island suffers further from strong winds and heavy rains during brief monsoon periods, which cause significant vegetation damage (Culek et al., 2006). Notably, cyclones in 2015 and 2018 devastated large areas of Socotra's unique woodlands, including frankincense (*Boswellia sp*.) and dragon's blood trees (*Dracaena cinnabari*) (Maděra et al., 2019).

SAPs, recognized for exceptional water-holding properties, offer a promising method to enhance soil quality and promote optimal plant growth. Their controlled release mechanism regulates water availability, promotes aeration, and supports nutrient diffusion, providing robust conditions for healthy root development. Applying SAP hydrogels may mitigate drought-induced stress, increase seedling establishment rates, and reduce mortality.

2 MATERIALS AND METHODS

The study was carried out in April 2025 in the Diburak region, using seedlings of *Boswellia elongata* and a hydrogel based on potassium carbonate. One gram of hydrogel retains 0.25 liters of water and remains effective for up to seven years (Hydrogel.cz, 2025). Seed availability was limited, resulting in only 20 *Boswellia elongata* seedlings, each less than one year old. Ten seedlings received hydrogel at 3 grams per liter of soil. Immediately after planting, all seedlings were watered with 1.5 liters of water. The soil was sandy-stony, and the planting area was fenced to protect the seedlings.

3 RESULTS

Results indicate that hydrogel application did not positively affect the growth of *Boswellia* seedlings on Socotra. Seedling mortality was approximately 30% higher among those treated with hydrogel. Additionally, average height increment was greater for seedlings without hydrogel (8.0 cm vs. 6.1 cm with hydrogel). Measurements were taken immediately after planting and again in August.

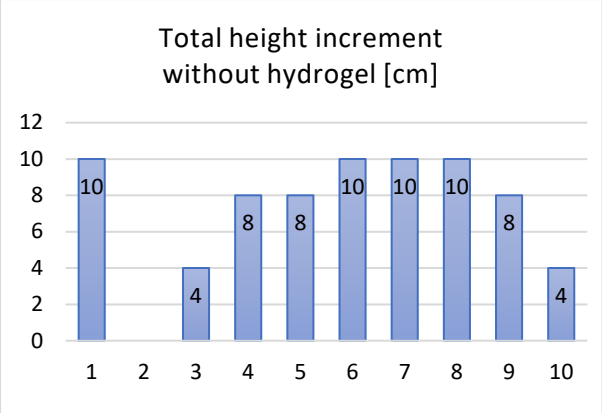

Fig. 1: Graph showing total height increment of seedlings planted without hydrogel

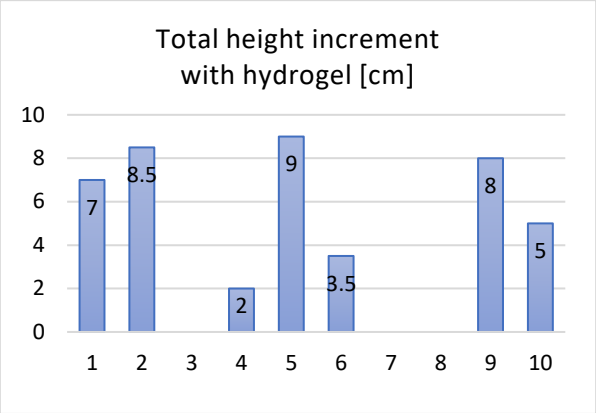

Fig. 2: Graph showing total height increment of seedlings planted with hydrogel

Although SAPs have shown positive results in annual plants, outcomes for woody species in arid tropical regions remain inconclusive and appear species dependent. For *Boswellia*, the present results suggest a negative impact from hydrogel use. Research in these environments must address challenges such as abiotic stressors, biological interactions (e.g., grazing, grasshoppers), and human-related factors. At present, hydrogels can be suggested mainly for use in forest nurseries, where growing conditions are more easily controlled.

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FACTORS AFFECTING INFESTATION OF TREES BY *COSSUS COSSUS* (LINNAEUS, 1758) (LEPIDOPTERA: COSSIDAE) IN THE CZECH REPUBLIC

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Keywords: ecological requirements, goat moth, pest management, wood and stem borer

1 INTRODUCTION

The goat moth (*Cossus cossus* (Linnaeus, 1758)) is the most widely distribute species of genus *Cossus* from the family Cossidae. Its larvae develop under the bark and in the wood of a variety of broad leaf trees and shrubs of about 20 plant families and cause physiological and technical damage to host woody plants. It is widespread in temperate zones of many European and Asian countries, and North Africa (Yakovlev, 2011). In the Czech Republic, it causes serious damage to various ornamental trees. To prevent and minimize losses from this pest infestations, it is important to have detailed knowledge of the characteristics of trees and habitats that are sensitive to infestation. The main goal of this study is to gain new knowledge on the ecological requirements of the species concerning tree and habitat characteristics to support effective monitoring and controlling this pest species.

2 MATERIALS AND METHODS

The study was conducted across various tree lines in the Czech Republic. Study localities were distributed in three different climate regions, based on mean annual temperature, and cover different tree sizes, tree species and surrounding habitats, such as urban areas, fields and forests. At each locality, all trees along the line were inspected for recent signs of infestation, feeding galleries, by *C. cossus* up to a height of 3 m above the ground to assess the infestation rate in a locality. Positive trees (with occurrence of *C. cossus*) were classified into 3 categories based on severity of infestation; low, medium and severe. For every positive tree observed, two closest negative trees (non-infested trees) were sampled to serve as a control. Additionally, in each tree line, at least 10 negative trees evenly dispersed along it were systematically sampled. The characteristics of tree and surrounding habitat, i.e. species, diameter at breast height (DBH), total height, old and recent mechanical stem damage, vitality, presence of breakage, stem cracks, hollows, fungi, bark roughness, bark coverage, exposure of trunks to *C. cossus* landing and type of surrounding habitats were recorded. The effects of all these characteristics on the severity of infestation and infestation rate by the species were investigated through random forest algorithms. The permutation importance was used to check the importance of the explanatory variables. Ordinal logistic regression was used to evaluate the statistical significance of each explanatory variable. Lastly, the marginal effects of the selected significant variables on the severity of infestation were visualised with a partial dependence plot.

3 RESULTS

A total number of 1,380 trees were sampled from 68 localities in the Czech Republic. Overall, the preference of *C. cossus* was comparatively driven by characteristics of individual tree more than habitat. The most significant factors were vitality, old stem damage, stem cracks and recent stem damage, respectively, and all these factors had positive effects on a probability of tree infestation by *C. cossus* (Fig. 1).

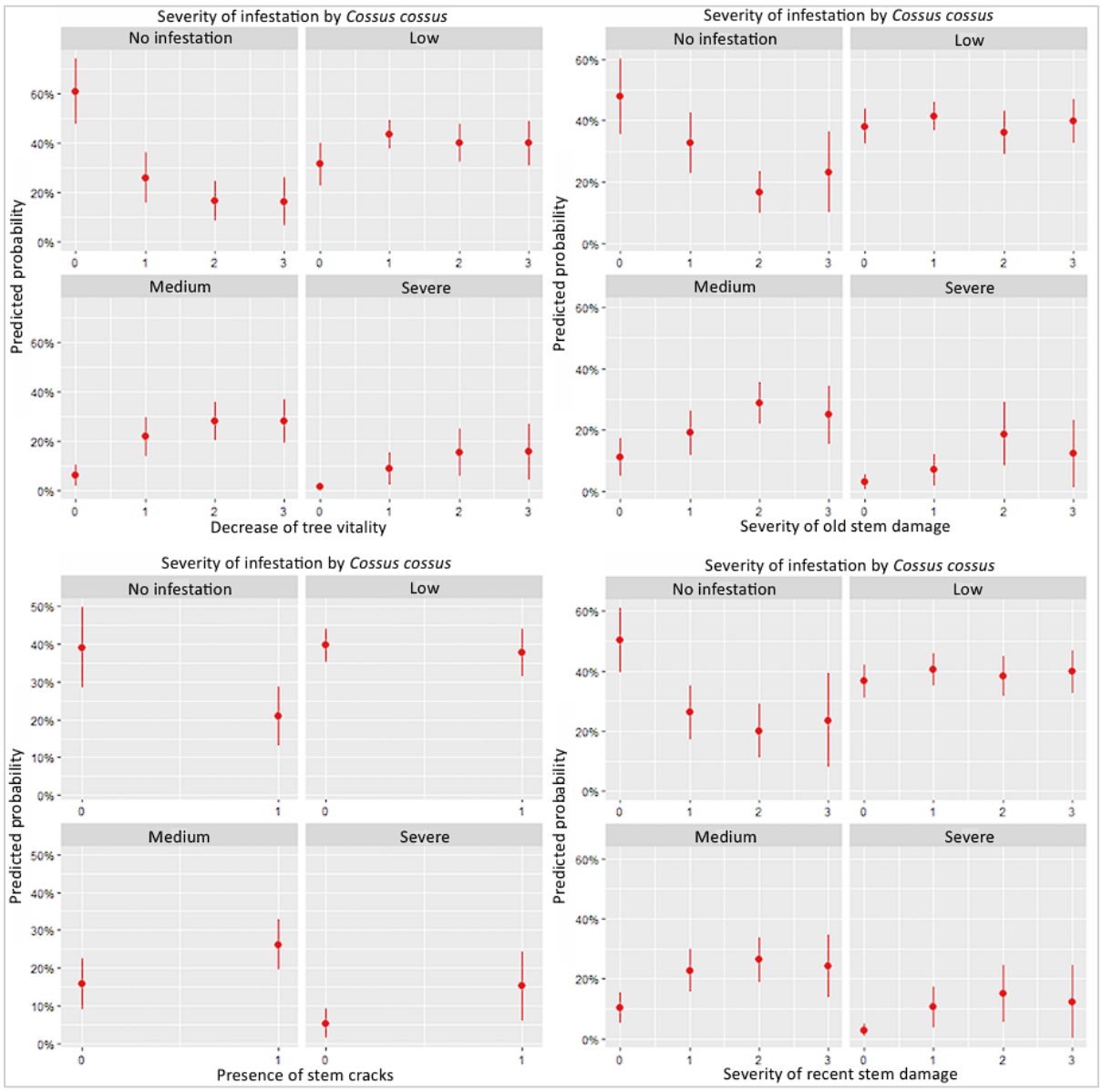

Fig. 1: Partial dependence plots showing the marginal effect of selected significant explanatory variables on a probability of tree infestation by *Cossus cossus*.

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THE INFLUENCE OF THINNING ON WATER FLOW IN YOUNG STANDS OF SESSILE OAK (*QUERCUS PETRAEA* MATT.) AND NORWAY SPRUCE (*PICEA ABIES* (L.) KARST.)

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Keywords: drought, stress, sap flow, water potential

1 INTRODUCTION

Long and frequent periods of drought already play a significant limiting factor for the survival of trees in forest stands (Dai, 2013). One of the effective means that foresters can use to deal with drought in forests is thinning. Thinning improves tree water status by lowering the interception but increased penetration of sunlight into the canopy may increase the evapotranspiration and stress load of individual trees. We used seasonal measurements of sap flow and noon water potential (Ψ_{noon}) to determine the effect of two thinning intensities on water relations of 20 – 30 years old sessile oak and Norway spruce stands.

2 MATERIALS AND METHODS

The study was conducted at three forest sites at the University Forest Enterprise. Two sessile oak stands were located near Útěchov (49.28° N, 16.62° E), and near Bílovice nad Svitavou (49.23° N, 16.67° E). The Norway spruce stand was located near Křtiny (49.32° N, 16.73° E). Thinning of medium and high intensity was performed in each plot and unthinned patch of the forest stand was left as a control. 6 individuals were selected for measurement in each forest type in all three forest areas. Sap flow and Ψ_{noon} measurements were carried out from June to October 2025. Sap flow measurements on selected individuals were performed by installing self-made Granier type measuring sensors. The heat balance sensors EMS 51A with TC-120A (EMS Brno, Czech Republic) were used to calibrate these Granier type sensors. Ψ_{noon} was measured every month on the same trees on which sap flow measurements were performed using a Scholander pressure chamber (PMS 1505D-EXP). For a comprehensive statistical evaluation of the measured data, principal component analysis (PCA) was performed. Regression analysis was performed for individual trees.

3 RESULTS

The sap flow of an average tree was highest in the stand with highest thinning intensity, between 0.88 – 0.91 m^3 $year^{-1}$ in both oak and spruce stands (Fig. 1). The lowest transpiration of the mean tree was in the dense unthinned stands (0.51 m^3 $year^{-1}$ in oak at Útěchov and 0.53 m^3 $year^{-1}$ in spruce in Křtiny) with the exception of oak in Bílovice nad Svitavou, where the lowest transpiration was in medium thinning (0.63 m^3 $year^{-1}$). Statistically significant differences in measured Ψ_{noon} between different forest types were not observed in Bílovice nad Svitavou (p = 0.933) or Útěchov (p = 0.540). A significant difference in measured Ψ_{noon} was only between high and medium thinning (p = 0.003) in Křtiny.

4 DISCUSSION

Preliminary results show that all high thinning intensities had higher seasonal flow rates of individual trees than the untouched forest type. This confirms the positive effect of thinning in the stand, at least interms of better water availability (Sohn et al., 2016).

The lower transpiration in the medium thinning intensity than in dense stand in Bílovice could be result of the damage to the soil and possibly the root systems due to thinning (Zhang et al., 2018).

The measured Ψ_{noon} showed that during this season there was no significant drought stress for the measured trees.

A smaller period of drought was observed only at the end of the August. However, this drought did not lower Ψ_{noon} enough to jeopardize the trees nor did we observe differences between the thinning intensities.

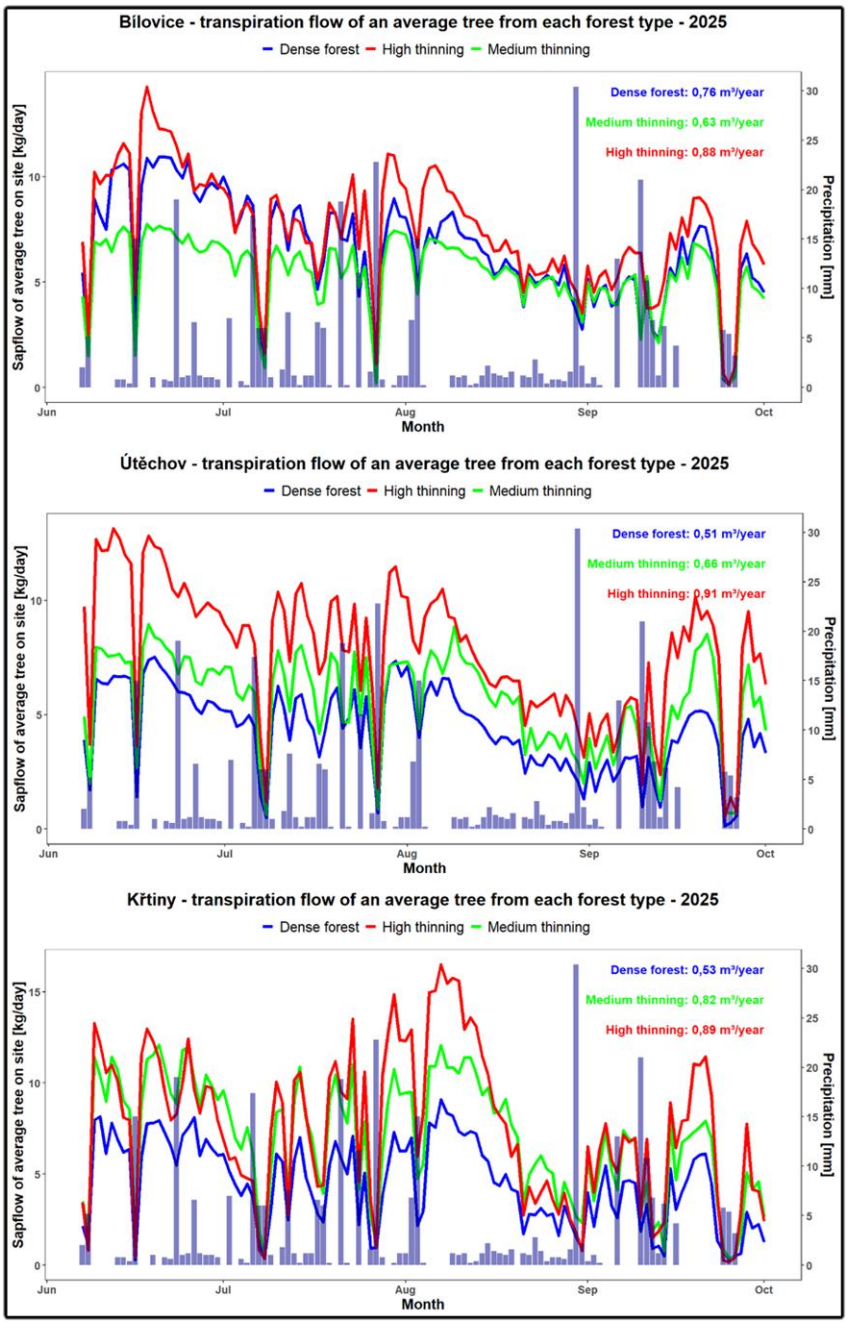

Fig. 1: Graphs of individual forest areas with sap flow ranges for average trees of individual forest types during the measured season.

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EFFECTS OF SILVER FIR (*ABIES ALBA* MILL.) REINTRODUCTION ON SOILS AFTER NORWAY SPRUCE (*PICEA ABIES* L. KARST) MONOCULTURES

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Keywords: decomposition, forest floor, humus conditions, mycorrhiza

1 INTRODUCTION

Planting of silver fir (*Abies alba* Mill.) into small–scale cuts might be an efficient way to reintroduce fir into Norway spruce (*Picea abies* L. Karst) monocultures where fir became absent (Poleno et al., 2009). This helps to diversify large–scale monotonous stands increasing the stands' resistence and resilience to climate change (Gulev et al., 2021; Honkaniemi et al., 2020). There has not been any research done on effects of young silver fir trees on spruce stands' soils yet. This study focuses on topsoil changes after planting silver fir on small scale clearcuts of Norway spruce. Topsoil is the interface between plants, animals and microorganisms providing the environment for biological organic matter changes and flow of nutrients and energy (Ponge, 2003). A crucial part of nutrition and vitality of forest stands are mycorrhisal associations (Anthony et al., 2022; Kujawska et al., 2023; Rudawska et al., 2016). So far 69 taxa associated with silver fir have been found prompting fir's ability to support also soil microbial diversity (Kujawska et al., 2023; Mrak et al., 2020; Rudawska et al., 2016; Unuk & Grebenc, 2017; Ważny, 2014; Ważny & Kowalski, 2017). The introduction of fir might thereby improve the stability and quality of topsoil in beforehand monotonous spruce stands.

2 MATERIAL AND METHODOLOGY

Three mature Norway spruce monocultures and two young silver fir stands originating from small–scale Norway spruce stand clearcuts were selected for this research. The stands are spread across two localities to prevent small-scale locality bias; Božejov in Vysočina region and Strakov in Pardubický region. Both stand types are present in both localities. The studied stands grow in the 5th altitudinal vegetation zone (*Abies–Fagus*) (NLI, 2023) as an optimal zone for silver fir. All the studied stands grow on sites of the *trophicum* or *acidophilum* ecological series (NLI, 2023). In each stand a representative sampling plot of at least 20 × 30 m was created. Each plot consists of 3 subplots directed diagonally from one corner of the plot to the opposite. In each subplot 4 sampling points were laid out in the northeastern, southeastern, southwestern and northwestern directions 2 meters far from the centre of the subplot. In each sampling point the organic L, F and H layers were collected using a circle of known area to quantify the horizons' accumulation. Afterwards, a shallow pit was created in each sampling point up to the ending depth of the organomineral horizon for later humus form classification. Then a soil depth of 0–10 cm was collected in northern, eastern, western and southern directions and in the centre of the middle subplot using tubes for later microbiome analyses focusing on the number of present bacteria and fungi taxa and their proportions. All sampling was done throughout one growth season to maintain maximal data comparability.

3 PRELIMINARY RESULTS

Spruce monocultures show higher organic layers' accumulation, reflecting the mor humus form classified in most of the spruce stand sampling points, and moder being the most present humus form in young silver fir stands, followed by mull. Silver fir stands show higher amounts of microbial community taxa of both bacteria and fungi. These preliminary results were acquired using Qubit Fluorometric Quantification.

4 ANALYSES TO BE PERFORMED

Total C, N and S contents are to be analysed using elemental analyser for their stocks' calculations from the measured quantity of accumulated organic layers. Analysis of plant-available nutrients in the H horizon will then be carried out using the Göhler extract, and the total nutrient content of both L and F biomass will be analyzed for further stock quantification. A reaction (pH) of H horizon will also be measured in H_2O and KCl. DNA sequencing and metabarcoding will be used for microbiome analysis as the DNA is already extracted and PCR has been amplified.

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Silva*Net* 2025

Landscaping and Landscape Conservation, Renewable Resources, Economics and Management, Forest Management, Silviculture, Applied Geoinformatics and Geodesy

IMPACT OF RIVER RESTORATION ON THE SOIL ENVIRONMENT: INITIAL LOCALITY SURVEY

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Keywords: headwater area restoration, soil moisture, soil temperature, water balance, watercourse

1 INTRODUCTION

The main objective of the project is to evaluate the transformative changes in the soil environment resulting from the river restoration as well as to demonstrate that a well-designed functional talweg in a headwater area can significantly improve moisture conditions. Wetlands like wet meadows, marshes, ponds and the side river channels play a crucial role in riverine ecosystems and water retention in the land (Štěrba et al., 2008). During a few last centuries, we have drained a million hectares of wetlands and ponds, as we have built thousands of kilometres of drainage systems and straighten the riverbeds to drain the land more quickly. Currently, there are several goals according to the European Union's Biodiversity Strategy for 2030 and European Union's Water Framework Directive leading to at least 25,000 kilometres of restored riverbeds by 2030 and achieving a “good status” of river bodies by 2027. The journey begins at the springs and headwater areas, as the stream restoration is considered to be a valuable strategy for climate mitigation by enhancing carbon storage in floodplain soils (Lininger and Lave, 2024).

The current state of knowledge highlights several key points connected with the headwater areas and springs restoration, as the project hypotheses are based on the most important ones.

(1) The first research area is tied with the organic matter transformation processes and carbon sequestration potential, while the stream restoration can significantly promote the organic matter deposition and water moisture levels, the potential will be further boosted by aboveground vegetation maximising the carbon sequestration and also all these issues lead to reducing soil, nutrient and carbon loss through erosion (Hinshaw and Wohl, 2023; 2021).

(2) The second key point consists in increasing the soil diversity after restoration. Firstly, the water quality improves, as well as the whole habitat is being in much better condition as a home for fish and other aquatic organisms (Roni and Beechie, 2012). Also, the riparian zone with its vegetation and fauna valuably contributes to the carbon storage (Riis et al., 2020). The soils with higher organic content have more microbial biomass and energy resources (Ontl and Schulte, 2012) and further the overall habitat complexity of headwater areas is often transcribed to soil diversity (Smith, 2018).

(3) Overall, the stream restoration has positive effect on hydrology, especially retention capacity and ground water level in the area, contributing also to better water balance in the surroundings.

2 MATERIAL AND METHODS

The river restoration and our research are held at the headwater area of Slavětínský potok (k.ú. Slavětín u Slavonice), South Bohemian Region. The first year of the project solution was targeted to project design, sensors installation and soil sampling before the watercourse rebuilding, which is planned to be implemented during the spring and summer 2026. Design of continual soil humidity and temperature measuring is based on the following three types of revitalization sections accompanying the riverbed rebuilding itself: (a) watercourse without any complementary element, (b) watercourse with planted vegetation and (c) watercourse with the pool. This year at each section according to the project plan, sensor profiles were placed in the distances of 1, 3 and 5 meters from the riverbed axe and in the 10, 30, 60 and 100 cm depths. After the complete restoration, sensor profiles will be doubled. Also meteorological station was installed. At the same time (spring 2025), soil samples were collected – one set from the sensor profiles copying the distances and depths and another sampling set from the random net located around the watercourse within three types of management – pasture (with the spring area included), arable land and future restored area (30 m wide zone from the watercoarse axe). The soil is planned to be analysed in this initial set before the restoration and also after (the 3rd year of the project). The analyses will include the hydrophysical properties (compact sample taken by iron cylinders) – soil bulk density, pF curves and the texture, as well as soil moisture and temperature measured by the sensors. Another analysis (composite samples) targeted to the humus conditions will include measuring the soil organic matter, total carbon (and its forms) and nitrogen, organic carbon and soil reaction. Also soil diversity is planned to be evaluated. The overall changes in water regime will be evaluated in the sense of the runoff measurement by Thomson V-shape weir, precipitation run-off measurement and geomorphometric conditions especially the erosion will be modelled.

3 CONCLUSIONS

In the first project year, initial design, soil moisture measuring and soil sampling were carried out. In the next year, the restoration will be implemented, as well as installation of other sensors and following soil analyses. The first results will be evaluated.

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WOMEN'S ROLE IN AGROFORESTRY AND FOOD SECURITY IN UGANDA

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Keywords: cultural and social norms, decision-making power, gender equity, indigenous knowledge resilience, land ownership, livelihood, sustainable development goals

1 INTRODUCTION

Agroforestry is a vital farming method which unites trees and shrubs with agricultural and livestock operations to enhance both sustainable land management and biodiversity conservation and improve rural community living standards (Jose 2009, Ntawuruhunga et al. 2023, Bamwesigye et al. 2024). Women actively participate in agroforestry success through their knowledge and traditional practices as well as their physical work, which leads to significant contributions to these practices (Okullo et al. 2022). Full involvement and participation of women in agroforestry initiatives has remained limited due to many obstacles (Sserunkuma 2005, Bamwesigye et al. 2020). The success of agroforestry practices in Uganda depends heavily on women who contribute through their traditional knowledge and labor and expert management capabilities. Women who act as traditional ecological knowledge holders lead the planting and preservation of trees and crops that strengthen both food security and environmental health, as well as rural livelihoods (Sserunkuma 2005, Nair 2011, Buyinza 2018, Bamwesigye et al. 2020, Bamwesigye 2025).

This research explored the roles and knowledge of women in agroforestry systems, as well as the various challenges they face within the community in Uganda.

Our research results demonstrated how women's empowerment can enhance environmental sustainability, as well as income and food security supporting broader development and resilience objectives in Uganda.

Highlights:

1. Women actively participate in Agroforestry and Agriculture activities in Uganda.
2. Knowledge and Expertise: women conserve traditional knowledge about cultural practices necessary for agroforestry success.
3. Women significantly contribute to food security and livelihoods, and sustainable environmental and economic advancement in many tribes and clans in Uganda.
4. Ugandan women have limited decision-making power and land rights, which are often supported by cultural and social norms.
5. Policy and gender inclusion, as well as broader community support, are needed to harness the potential for resilience and capacity.

2 MATERIALS AND METHODS

The research study employed a qualitative method. A Focus Group Discussion (FGD) method was used to examine the role of women in agroforestry in Uganda.

The focus group discussions were carried out in two districts (Kampala and Wakiso) of Uganda. The FGDs were carried out in June 2025. The study comprised eight groups, primarily consisting of individuals between the ages of 18 and 35.

The groups had a recommendable number of participants, ranging from 6 to 10 people. More so, the time requirement of at least 60 minutes was observed.
The study leader asked for group members herein participants for their consent to participate in the study. They all agreed to the study.

3 RESULTS

The focused group discussions about women's roles in agroforestry success agreed that women play essential multiple functions in this context. All groups confirmed that women take part in complete agroforestry processes as much as general agriculture, from preparing the land to planting and then caring for the trees until they are ready for harvesting. The tasks of weeding, tree pruning, and care duties belong to women because women play the most important role in maintaining healthy, productive agroforestry systems. Overall, all the groups agreed that Ugandan women perform essential agricultural work, but their roles remain defined by traditional gender expectations.
All groups agreed that women must be involved in agroforestry because it leads to sustainable environmental management and economic advancement.
The collective responses demonstrated that agroforestry projects require women's knowledge, rooted in cultural traditions, to succeed in forestry and agroforestry. Cultural and traditional knowledge and skills about medicinal plants and land management held by women provide essential information that boosts productivity and sustainability and helps communities accept these projects.
The discussions indicated that women in Ugandan communities encounter multiple barriers to making decisions about agroforestry, mainly because of deep-rooted social norms and cultural expectations and economic limitations.
The restrictions on their right to land ownership, together with their exclusion from community decision forums, reduce their ability to make decisions.

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HYDROBAL 2: IMPACT OF CLIMATE CHANGE ON WATER IN THE SERBIAN LANDSCAPE

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Keywords: hydrology, hydrological extremes, microwatershed, runoff coefficients

1 INTRODUCTION

This abstract presents changes in climate and runoff parameters in three forest microbasins in the mountains of central Serbia, near the village of Brezna. It compares the situation described by original measurements in these basins in the 1980s with the current situation (early 2020s). It examines changes in the rainfall-runoff process and describes them in terms of climatic changes, vegetation, and runoff volume.

2 METHODOLOGY

Three microbasins (M I, M II and M III) in the mountains of central Serbia were used for this research. MI is a catchment area covered with a mixture of coniferous trees, MII is a forestless catchment area with solitary trees, and MIII is a forested catchment area with mixed stands.

A network of stabilized hydrological stations was used for data acquisition. The hydrological stations are equipped with a combined Thomson-Cipoletti weir. The hydrological stations are equipped with a combined Thomson-Cipoletti weir and a TSH22 submerged hydrostatic probe (Fiedler Automatic Monitoring Systems AMS, Czech Republic). Climatic data were obtained from the E-OBS dataset (version 31.0e, regular grid 0.1 degree, grid 43.55–20.65) and the original Macans study (Macan, 1985). From the 15 minutes of logged data, flow data were obtained, which were processed and cleaned into a final working database. For a basic comparison of hydrological parameters, hydrographs were compiled from these data for both individual years and the entire study period. To evaluate changes in climate and runoff parameters, we used differences in average monthly values (sums or averages) from the study periods.

3 RESULTS AND DISCUSSION

When monitoring changes in forest microbasins, it is important to keep in mind changes in vegetation over time. To complete the picture, it should be noted that in the M I basin, the vegetation aged by 40 years, M II remained meadowland, and M III vegetation aged by 40 years.

The results show that while the total annual precipitation remains quite stable, with only a slight increase, there is significant fluctuation in precipitation throughout the year. In addition to short periods of potential moisture abundance, this mainly results in significantly drier summers. Result data also shows that there has been a significant increase in average temperatures (by 3.2 °C) over the last 40 years. In general, it can be said that while the increase in temperatures is below average in spring (March, April, and May) and autumn (September, October, and November), the increase in average temperatures is above average in summer (June, July, and August) and winter (December, January, and February).

The measured flow data in Table 1 show a significant decrease in water runoff from the catchment area (annual averages in the years studied: M I 36%, M II 67%, and M III 45%), and also show a shortening of the winter period and, on the other hand, a doubled prolongation of the summer drought period, disrupted only by a few extremes, when a significant increase in runoff (e.g., 14,120%) is due to zero runoff in the given months of the historical period. The percentages in the table show significant variability in runoff in individual months compared to the same months in the historical measurement period (e.g., 7% in March and 349% in the following month of April for the M I basin).

Tab. 1: Changes in total runoff amounts calculated from data for 1980–1983 and 2022–2025

	M I	M II	M III
Month	Runoff	Runoff	Runoff
1	75%	35%	121%
2	8%	6%	25%
3	7%	4%	4%
4	349%	195%	155%
5	160%	43%	28%
6	175%	132%	136%
7	1%	1%	1%
8	32%	1,520%	0%
9	0%	5,212%	14,120%
10	0%	0%	54%
11	43%	55%	23%
12	131%	70%	97%
1-12	64%	43%	55%

From the lower runoff values in the winter months (Fig. 1), we can conclude that a) there is less water stored in the snow cover and b) the winter season is shorter. This can be observed in the form of a significant decrease in runoff as early as January, compared to similar decreases observed in the 1980s, which did not occur until April. However, as the measured differences in temperature, precipitation, and runoff still exceed the estimated and modeled climate changes, it is possible that the extreme weather in the Goč Mountains has exceeded the gradual effects of climate change and at this point, the positive impact of vegetation is becoming negligible.

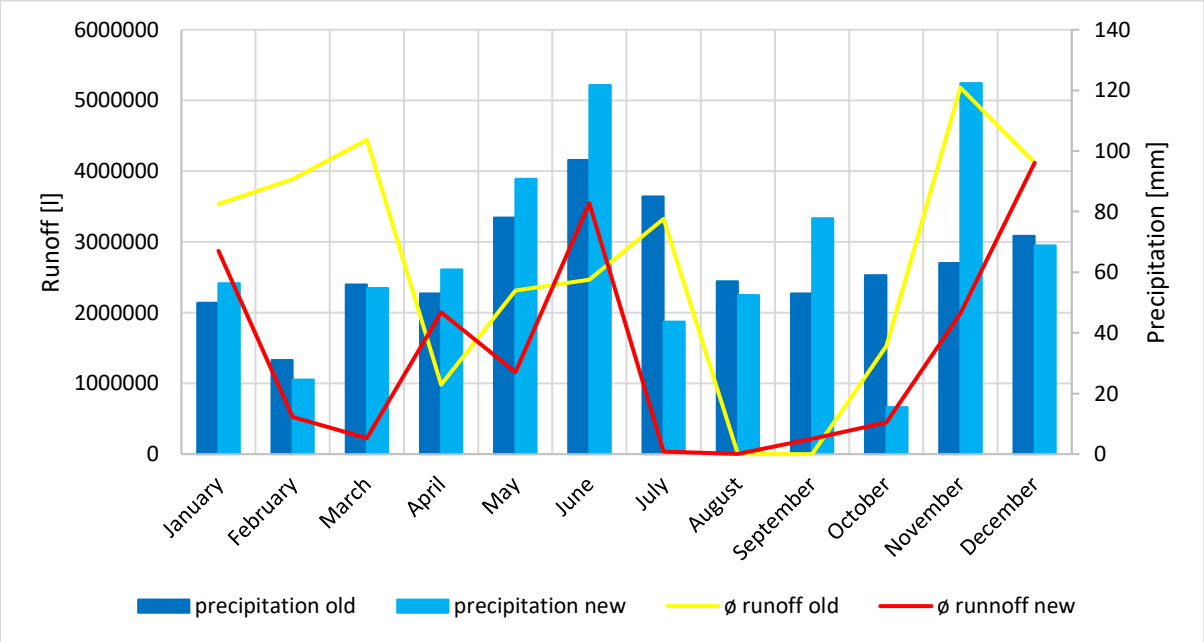

Fig. 1: Monthly average runoff amounts and precipitation 1980–1983 vs. 2022–2025

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EVALUATION OF FOREST REGENERATION SUCCESS USING MULTISPECTRAL DATA ACQUIRED BY UNMANNED AERIAL VEHICLE

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Keywords: CNN, convolutional neural networks, identification, Random Forest, supervised classification, support vector machine, vegetation index

1 INTRODUCTION

During this year of implementation, methods for processing remote sensing (RS) data were comprehensively evaluated for assessing natural forest regeneration in the University Forest Enterprise Křtiny. Data collection was carried out using RGB and multispectral cameras mounted on an unmanned aerial vehicle (UAV) flying at a very low altitude. After data acquisition, point clouds and digital surface models (DSM) were generated, along with orthophotos and vegetation indices derived from the collected multispectral imagery. The vegetation cover analysis included the assessment of the number of individuals in the study plots using vegetation indices. In addition, a local maxima detection method was applied to the digital surface models and point clouds to estimate the number of regeneration individuals. Gaps in natural regeneration were also identified. Within the analysis, machine learning methods such as Random Forest, Support Vector Machine, Maximum Likelihood, and Deep Learning were applied for automated vegetation cover classification.

2 MATERIALS AND METHODS

The methodology focused on the use of unmanned aerial vehicles (UAV) for assessing natural forest regeneration within the area of the University Forest Enterprise Masaryk Forest in Křtiny [1,2]. Aerial imaging was conducted using a DJI Mavic 3 Enterprise UAV equipped with an RGB camera and a Parrot Sequoia+ multispectral sensor. Images were captured with high overlap (85% forward and 80% side) at a flight altitude of 80 m above the digital terrain model. The GNSS RTK system connected to the CZEPOS network ensured positional accuracy within 20 cm. The collected data were processed in Agisoft Metashape photogrammetric software using the Structure from Motion (SfM) method to generate a point cloud, digital surface model (DSM), orthomosaic, and several vegetation indices (NDVI, GNDVI, NDRE, GRVI, PSRI, ReChl, SR). In ArcGIS Pro, machine learning methods—Random Forest, Support Vector Machine, Maximum Likelihood, and Deep Learning—were applied to classify vegetation cover and identify regeneration and canopy gaps [3,4,5]. Validation was performed through field surveys, during which the positions, heights, and counts of regeneration individuals were recorded using GNSS. The aim of the methodological approach was to evaluate the efficiency of UAV photogrammetry and remote sensing methods for quantifying natural regeneration and to propose an optimized methodology for its monitoring.

3 RESULTS

The classification results confirmed that all tested machine learning methods achieved a comparable level of accuracy, with differences observed in their sensitivity to individual vegetation classes. The highest overall accuracy (73%) was obtained using the Support Vector Machine (SVM) method, which also showed relatively balanced user and producer accuracies (51.7% and 42.9%). The Random Forest method achieved an overall accuracy of 70.6% with a lower producer accuracy (37.1%), while the Maximum Likelihood Classification reached the lowest overall accuracy of 69% and a Kappa index of 0.208. In contrast, Deep Learning achieved the highest producer accuracy for the regeneration class (65.7%) and the highest Kappa index (0.306), despite its lower overall accuracy of 68.3%, indicating its better capability for accurate regeneration detection. The combination of multispectral indices (particularly NDVI, NDRE, and GNDVI) with classification methods effectively distinguished areas of active regeneration from non-forested surfaces. Field verification confirmed sufficient accuracy and practical applicability of UAV photogrammetry for assessing natural forest regeneration at the University Forest Enterprise Křtiny.

Tab. 1: Accuracy metrics for regeneration class

Method	Overall Accuracy (%)	User Accuracy for Regeneration (%)	Producer Accuracy for Regeneration (%)	Kappa Index
Support Vector Machine	73.0	51.7	42.9	0.29
Maximum Likelihood	69.0	43.6	40.0	0.208
Random Forest	70.6	46.4	37.1	0.22
Deep Learning	68.3	45.1	65.7	0.306

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ACKNOWLEDGEMENT

The research was supported by funds from project no. IGA24-FFWT-TP-002, conducted under the Internal Grant Agency of the Faculty of Forestry and Wood Technology at Mendel University. In 2025, a paper in a journal with impact factor was published as part of the project: KRAUSKOVÁ, D. et al., 2025. Accuracy Assessment of iPhone LiDAR for Mapping Streambeds and Small Water Structures in Forested Terrain. Sensors [online], 25 (19), 6141. DOI:10.3390/s25196141

INFLUENCE OF SILVICULTURE TREATMENTS ON CLIMATE-GROWTH RELATIONSHIPS IN SPRUCE STANDS: A CASE STUDY FROM SOUTHERN SWEDEN

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Keywords: climate change, *Picea abies*, silviculture management, thinning

1 INTRODUCTION

In the last decades, Norway spruce stands have been disintegrated due to frequent drought periods followed by secondary biotic pests, causing severe damage to these stands. These changes have harmed the whole ecosystem. For this reason, it is necessary for current Norway spruce stands in the middle and mountainous altitudinal zones to maintain at least partly wood-producing function while lowering risks of their disintegration to avoid the same situation in the future. This research addressed the following questions: Which silvicultural approach is the most appropriate for still occurring pure Norway spruce stands? Are pure Norway spruce stands under adequate silvicultural management sustainable in the following decades, or will Norway spruce (*Picea abies*) be only admixed in forest stands in the middle altitudinal zones?

2 MATERIAL AND METHODS

The project used long-term silvicultural research plot managed by SLU (Swedish University of Agricultural Sciences) and Tönnersjöheden Research Station to study how different thinning methods affect drought resilience in pure Norway spruce (*Picea abies*) stands Sweden. Each 50 × 50 m plot (with a 10–15 m buffer zone) included three variants: control (1), thinning from above (2), and thinning from below (3). Sampling and data processing followed Jablonická et al. (2025).

3 RESULTS AND DISCUSSION

As shown in Fig. 1, all thinning variants exhibited similar overall trends in the Swedish experimental area. With precipitation, predominantly positive correlations during the spring of the year of tree-ring formation were observed, while correlations were mostly negative in the autumn of the preceding year. This suggests that higher spring precipitation supports radial growth, whereas wetter conditions before dormancy may have less favourable effects (Bréda et al., 1995; Sohn et al., 2016). A statistically significant negative correlation was observed for temperature in November of the preceding year in variant 2 (thinning from above). Warmer late-autumn conditions may increase respiration and reduce carbohydrate reserves, negatively affecting subsequent growth (Sperling et al., 2025). For SPEI, the most pronounced deviation occurred in the year preceding ring formation, where thinning from below showed a significant negative influence, indicating higher drought sensitivity in stands with more open canopies. These findings align with previous research showing that thinning alters microclimate and water balance, which can amplify drought stress if canopy opening is excessive (Vicente-Serrano et al., 2010).

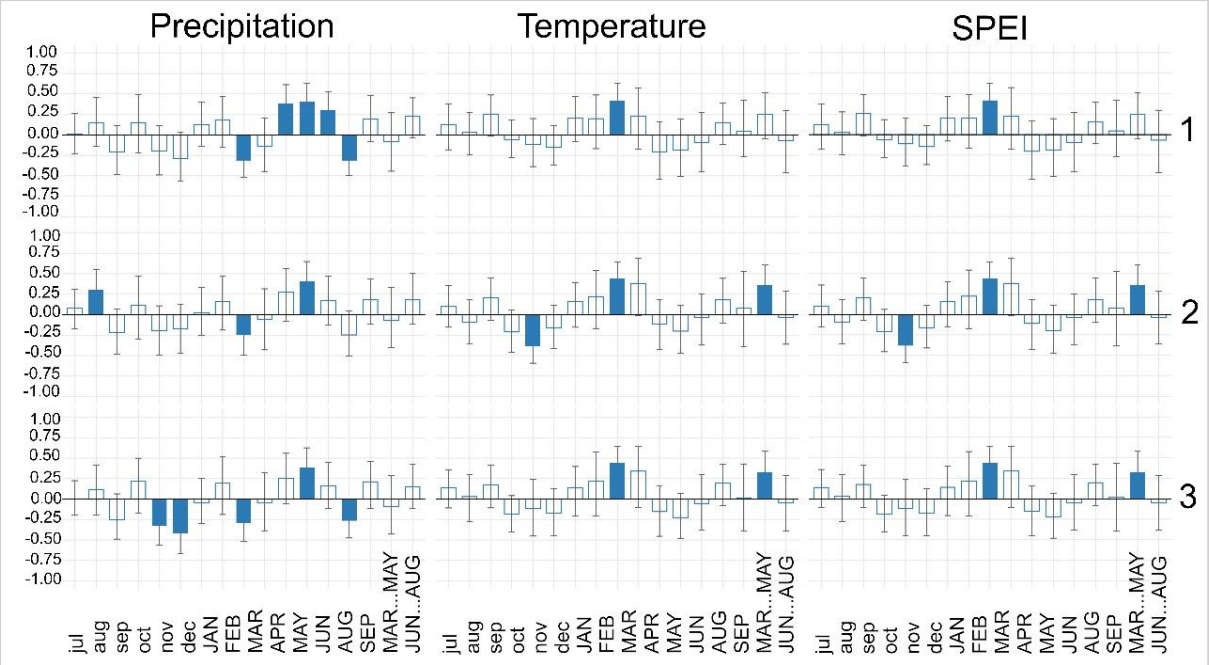

Fig. 1: Pearson correlation between tree ring widths and climate. 1 – control plot with no silvicultural intervention; 2 – thinning from above; 3 – thinning from below. SPEI – Standardised Precipitation-Evapotranspiration Index. Months written in lowercase are from the year preceding the creation of the tree ring, and months written in uppercase are from the year of the creation of the tree ring.

4 CONCLUSIONS

Precipitation positively affected radial growth in spring, while autumn precipitation and November temperatures of the previous year had a negative impact, especially in thinning from above stands (variant 2). The strongest negative SPEI effect was observed in the year before ring formation, particularly in thinning from below, indicating higher drought sensitivity. These results highlight the importance of thinning type and climate variability in silvicultural planning. Moderate crown thinning helps maintain microclimatic stability, supporting forest resilience under drought stress.

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ACKNOWLEDGEMENT

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UNCONTROLLED SETTLEMENT DEVELOPMENT: IMPACTS ON SOCOTRA´S NATURE AND LANDSCAPE

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Keywords: biodiversity loss, ecosystem threats, endemic species, overgrazing, Socotra Archipelago, sustainable development, urbanization

1 INTRODUCTION

The Socotra Archipelago, located in the northwestern Indian Ocean and administered by Yemen, is renowned for its exceptional biodiversity and high degree of endemism. The archipelago comprises four islands, with Socotra being the largest, covering approximately 3,600 km² and accounting for around 95% of the total land area [1,2]. Socotra harbours over 827 plant species, approximately 37% of which are endemic [3]. This richness is attributed to the island's long-term geographic isolation, diverse topography, and arid climate influenced by seasonal monsoons [2].

Traditionally, locals practiced a semi-nomadic lifestyle, rotating between pastoralism and fishing. This strategy minimized continuous environmental pressure on any single area and enabled sustainable resource use over generations [2]. However, in recent decades, rapid socio-economic changes have occurred. The population now exceeds 100,000, accompanied by the permanent establishment of over 300 settlements across the island [2,4,5]. This has led to urban expansion and altered land use, accompanied by unregulated livestock breeding and increased livestock numbers, which together intensify anthropogenic pressures on the island's ecosystems [2,5,6,7]. This study hypothesizes that uncontrolled settlement development, coupled with intensified grazing pressure, is negatively impacting Socotra's natural environment and local endemic species. In particular, woodlands are being directly destroyed by urban expansion, and populations of woody plants are gradually declining.

2 MATERIALS AND METHODS

The study aims to assess the impact of settlement development on Socotra's environment, with a particular focus on woody vegetation. A multi-scale approach combines field vegetation surveys, drone imagery, and GIS-based spatial analysis.

Twenty villages were selected across four altitudinal vegetation zones (AVZs) and categorized by population size. In each, a single 2 km linear transect was established (1 km each direction from the village centre, 200 m wide) and surveyed using drone photogrammetry to analyse vegetation structure, spatial patterns, and land cover.

Along each transect, three circular plots (7 m radius) are placed at distances of 150 m, 300 m, and 450 m from the centre. Within each plot, all woody plants are recorded (species, height, coordinates) using Field-Map (IFER). In addition, each plot is also documented with a vertical drone photograph to support ground-based observations and estimate canopy cover. For comparative analysis, an equal number of control plots (n = 20) was established in uninhabited areas within the same AVZs.

Data are analysed using geospatial and statistical tools to identify vegetation patterns related to settlement proximity, comparing inhabited vs. uninhabited areas and distance gradients.

3 RESULTS

Preliminary analysis suggests the hypothesis is likely valid: urban growth correlates with a decline in woody vegetation near settlements. A particularly evident case is the capital city of Hadibo, where settlement expansion between 2016 and 2025 is clearly visible (Figs. 1 and 2). The settlement area has increased by approximately 36%, indicating significant land cover change over the past decade.

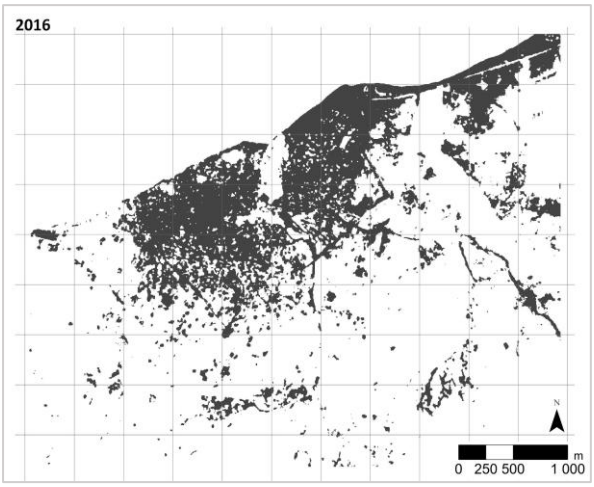

Fig. 1: Settlement in Hadibo, 2016

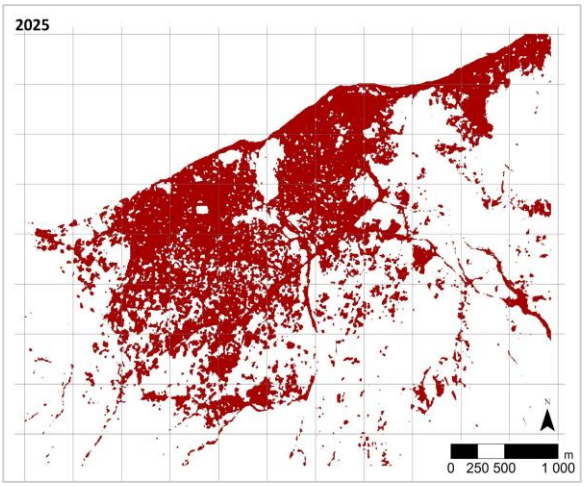

Fig. 2: Settlement expansion in Hadibo, 2025

These findings are based on initial remote sensing data and field observations during the early stages of the research. However, the dataset is not yet complete, and the main data collection phase is currently ongoing (October–November 2025). Final results may differ as more data becomes available and further analysis is conducted.

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COMPARISON OF RAINFALL PARTITIONING AND ESTIMATION OF THE UTILISATION OF AVAILABLE WATER IN A MONOCULTURE AND MIXED FOREST

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Keywords: effective precipitation, interception, stemflow, throughfall

1 INTRODUCTION

The climate change is bringing about change in the annual precipitation distribution, including longer periods of drought and more frequent of torrential rains [1]. Precipitation can fall to the ground as throughfall or stemflow (together "effective precipitation") [2]. The throughfall is, when the rain drips through the crown onto the soil, and the stemflow is, where the water flows down the moist branches and the trunk to the soil around it [3]. The rainfall partitioning in the stand varies among species [4]. The effective precipitation constitutes the amount of precipitation that the trees can actually utilise. Unutilized part of precipitation is interception, where the amount of the precipitation entrapped by the crowns can make up (based on tree species) to 50% of the total annual precipitation [5].
To address the utilization of precipitation of monoculture stands and their mixture, we focused on the differences between the four forests in the Czech Republic.

2 MATERIALS AND METHODS

The measurement was carried out from 15th of April to 20th of October 2025 in four researched forests that were located near Brno at an altitude of around 400 m a.s.l. For comparison, the following these forests were chosen:

- Beech monoculture (Beech) – no undergrowth, 21 years old, 2.2 ha in size;
- Fir monoculture (Fir) – no undergrowth, 26 years old, 0.38 ha in size;
- Oak monoculture (Oak) – no undergrowth, 28 years old, 0.63 ha in size;
- Mixed forest (Mixed) – no undergrowth, 24 years old, 0.29 ha in size.

In each forest, research plot with size 0.25 ha was performed. The height, crown projected area (CPA) and diameter at breast height (DBH) were measured on all trees therein. A measurement grid was laid out on all plots. Above these points and troughs, the plant area index (PAI) was measured. Precipitation was found out from the weather stations in Křtiny, Bukovinka and Babice nad Svitavou.
The throughfall was collected using the rectangular plastic troughs (five in each plot), and sent through a small pipe to a small plastic barrel.
The trees, on which the stemflow was measured, were chosen according to their species composition and social position in the forests. Through a piece of garden hose (that was wound around the trunk of each tree, fastened and cut off along its entire length) flowed water from trunk into a barrel.
The water volume in the barrels was measured ca. each week. The weight of the filled barrel was measured using scales, and the weight of the empty barrel was subtracted (from this weight), in order to obtain the net weight of the water. Since 1 litre of water weighs 1 kg, we converted the net weight (in kilograms) to volume (in litres). The

throughfall was calculated to volume per square metre and re-calculated according to the mean value of PAI in the forests and above the troughs. With DBH and CPA, the amount of the stemflow from each tree was calculated using regression curves for each forest and species and re-calculated per square metre.

3 RESULTS

The precipitation was 408 mm in period from 15th of April to 20th of October 2025. The amount of water received onto the soil from the stemflow was the highest in beech and the lowest in fir (stemflow in fir was less about 76% than that in beech). The amount of water from throughfall was the highest in oak and the lowest in fir (throughfall in fir was less about 47% than that in oak). The highest interception (63% of whole precipitation) was recorded in fir, which was about 29%, 47% and 55% more than those in mixed, beech and oak, respectively.

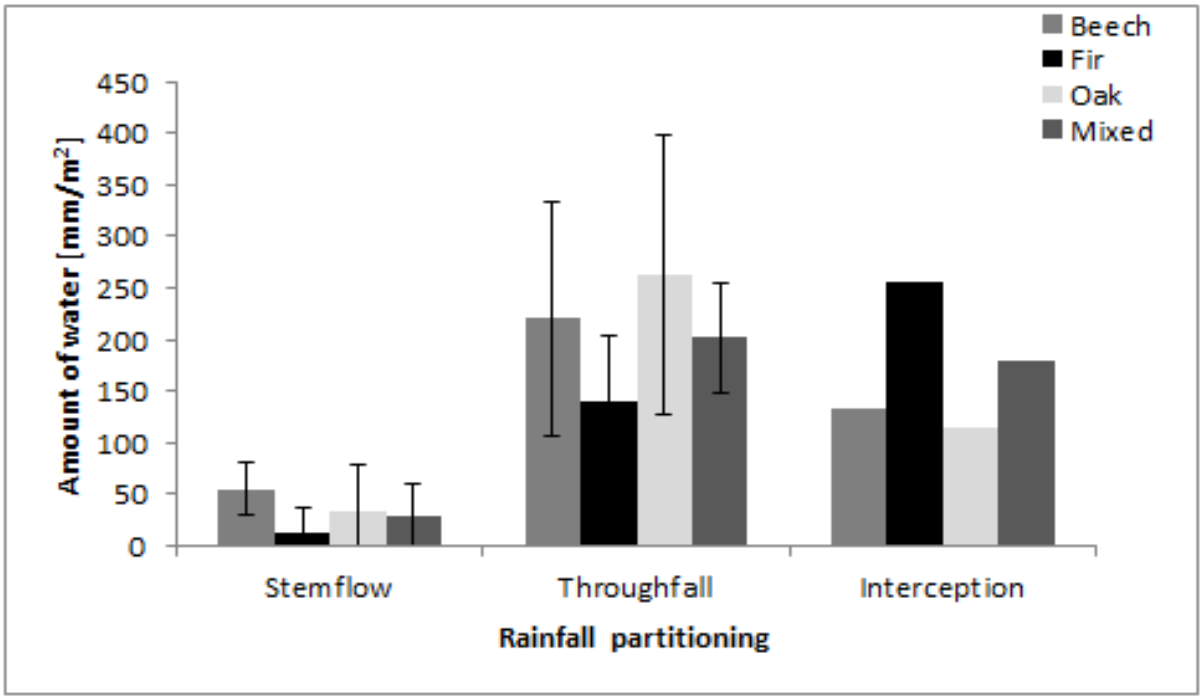

Fig. 1: Rainfall partitioning according to tree species. Whiskers denote standard deviations.

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THE IMPACT OF WILD-GAME AND LIVESTOCK ON ACTIVELY MANAGED COPPICE – RESULTS IN 2025

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Keywords: grazing, litter raking, sessile oak, standard, stool, thinning

1 INTRODUCTION

The project seeks to assess the impact of grazing, wild game, and litter raking, as well as to measure their effects on the condition of the coppice from dendrometric, pedological, and geobiocoenological perspectives. This study primarily focuses on analyzing the dendrometric characteristics of sessile oak stands that have been converted to coppice-with-standards. In addition, pedological data focus on the organic and organomineral soil horizons, specifically on the C/N ratio.

2 MATERIALS AND METHODS

In 2017, research plots were established at TFE MF Křtiny in the stand under conversion to coppice-with-standards. The standards were released by thinning in the winter of 2017/2018. Thus, we have an eight-year time series of measurements for the standards (1 year before and 7 years after harvest). Plots are established with four treatments: coppice-with-standards (CWS), CWS with litter raking (R), CWS with grazing (G), and CWS with litter raking and grazing together (R+G). Sessile oak standards in control plots (without treatment) are also measured. The basal area increment of sessile oak standards was calculated and modelled using a generalized linear model with a gamma distribution. Pedological samples were taken this year from organic and organomineral horizons, from a total of 60 sampling points. All analyses were performed at a significance level of $\alpha=0.05$.

3 RESULTS

The dendrometric results have shown that the increment of sessile oak standards is influenced by the DBH of the standard before the harvest, the type of historical management, and the time that has passed since the thinning (Fig. 1). Fitted values increase with increasing DBH of the standard before thinning and differ between evaluated years. The highest basal area increment was observed on plots with sheep grazing and CWS management, followed by plots with sheep grazing combined with litter raking and CWS management, and CWS management alone. The smallest values of basal area increment were found on plots with litter raking and CWS management.

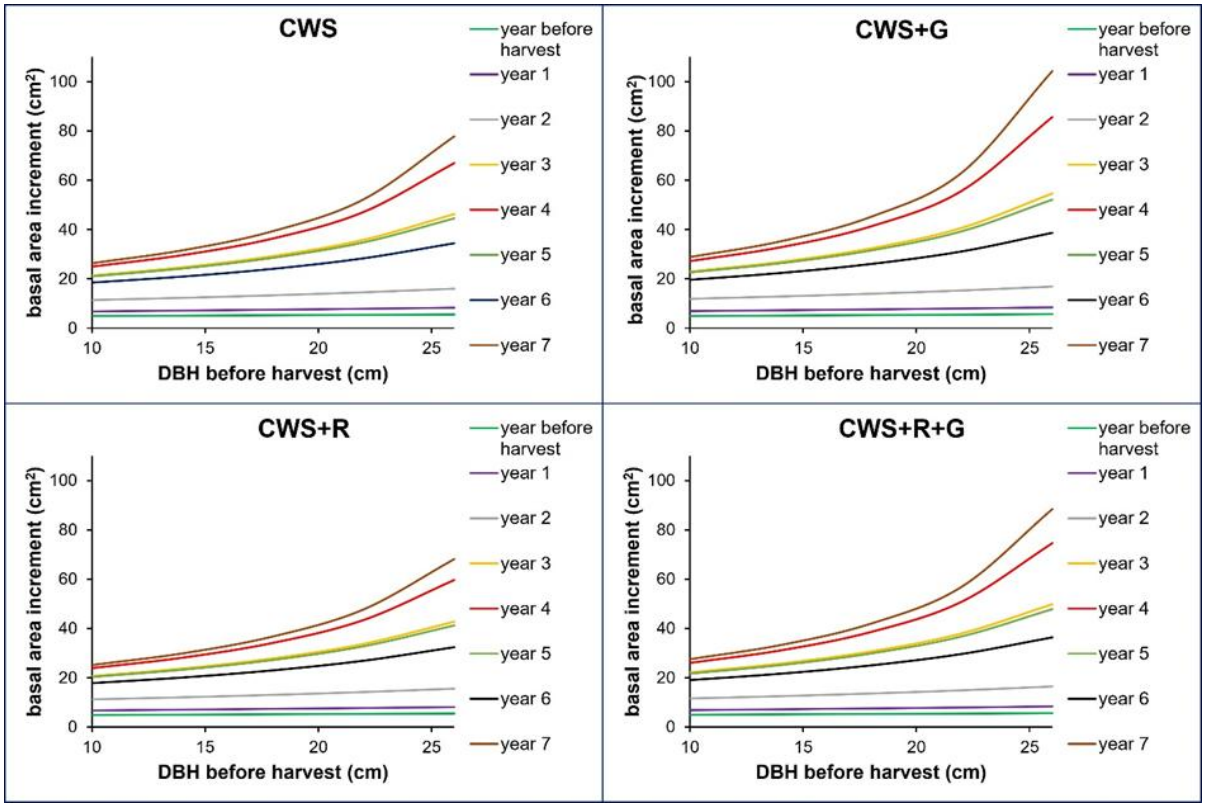

Fig. 1: The modelled basal area increments of sessile oak standards between different treatments during the studied years. (DBH: diameter breast height, CWS: coppice-with-standard, G: grazing, R: litter raking)

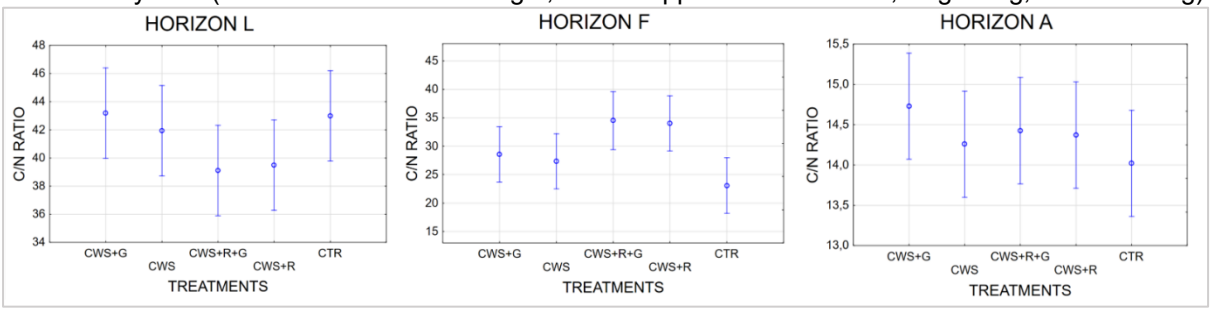

Fig. 2: Comparison of mean values of the C/N ratio (with 95 % confidence intervals) between different treatments in the studied soil horizons in 2025. (CTR: control, CWS: coppice-with-standard, G: grazing, R: litter raking)

Pedological data focus on the C/N ratio in the organic and organomineral horizons between different treatments in 2025. It can be seen that the development of the C/N ratio is different for each horizon. In the L horizon, the values are the lowest for the treatment CWS+R+G and CWS+R, while they are the highest for the F horizon. In the A horizon, the treatment CWS+G is the highest.

4 CONCLUSIONS

This project and research aimed to evaluate the impact of the practices of traditional forest managements, which are nowadays no longer widely applied. The smallest values of basal area increment were found on plots with litter raking. If we focus on pedological data, the C/N ratios are different, especially in the L and F horizons.

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This study was supported with funding provided by the Internal Grant Agency, Mendel University in Brno, project number IGA-LDF-23-TP-002.

IMPACT OF CLIMATE CHANGE ON EFFECTIVE PRECIPITATION BEECH FORESTS IN DIFFERENT THINNING REGIMES

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Keywords: beech, drought, interception, stemflow, throughfall

1 INTRODUCTION

Nowadays, we are struggling with a changing climate. Specifically, it is drought, which troubles the whole world [1]. Lack of water during the growing season weakens growth, reduces the availability of life, reduces growth and ultimately leads to complete failure of the tree's lifespan. Dry periods alternate with torrential rains. After a dry period, the soil gradually soaks up and most of the water drains away. And therefore, these torrential rains result in soil erosion. Drought damaged roots limit the ability of trees to absorb water from the soil. Beech is a relatively plastic tree, but in lower forest vegetation zones it begins to be more threatened by drought, which is manifested by the dying of the trunk, the drying of the primary structure of the crown from the top, etc. Main input of water to trees is through part of precipitation - stemflow and throughfall (i.e. effective precipitation), and the rest of precipitation - interception - stay on the crowns and evaporates back into the atmosphere. When focusing on so-called valuable production, it is therefore necessary to ensure sufficient usable rainfall for selected target trees by appropriately releasing them. The stemflow is run-off water along the trunk and its amount depends on tree species and the shape of the crown [2]. Throughfall is precipitation penetrating through the tree crowns to the soil surface and its amount depends on tree species and leaf area index (LAI) [3].

2 MATERIALS AND METHODS

The aim of the project was to determine how differently thinned beech stands are influenced by drought. The areas that were selected for our research were in the University Forest Enterprise Masaryk Forest in Křtiny. There were 8 areas where we carried out different interventions. The 1st area where no intervention was carried out (BZS), the 2nd area was thinned according to common thinning (LHP). On the 3rd and 4th area, we selected 50 target trees and removed 1-2 or 3-4 their competitors. On the 5th and 6th area, we selected 80 target trees and removed 1-2 or 3-4 their competitors. On the 7th and 8th areas, we selected 110 target trees and removed 1-2 or 3-4 their competitors. We also measured the tree diameter and crown projections. Measuring of the throughfall – we installed 3 collecting troughs with barrel on all the above plots. The amounts of the water were measured weekly. The stemflow were performed on 3-6 trees per plot. The co-dominant and suppressed trees were selected. A hose that is wrapped around the trunk circumference at an angle of 30°. The hose was fixed from the bottom with polyurethane foam. The top of the hose was then cut off, leaving a larger part of the hose on the outside to prevent possible spillage of water from the trough [2]. The defluent water was kept in barrel. The amounts of the water were measured weekly. The amount of the water from the stemflow and throughfall were gradually recorded in liters. Each barrel was marked and assigned to individual areas.

3 RESULTS

The precipitation fell 414 mm from 1st April to 20th October. We measured througfall and stemflow and calculated interception during this period. We entered these values into Fig. 1. The values of the interception were the greatest of all precipitation partitioning in almost all thinning variants. Interception was more than 60% in the 110 1-2, 110 3-4 and LHP variants and the lowest (less than 50%) was in the 50 1-2, 50 3-4 and 80 3-4 variants. The values of throughfall were very variable. The lowest values (less than 35%) were in the 110 1-2, 110 3-4 and LHP variants and, on the other hand, the greatest ones (more than 50%) were in the 50 3-4 and 80 3-4 variants. The stemflow had the lowest values of precipitation partitioning. These values never exceeded 5% and at most case was lower than 3%.

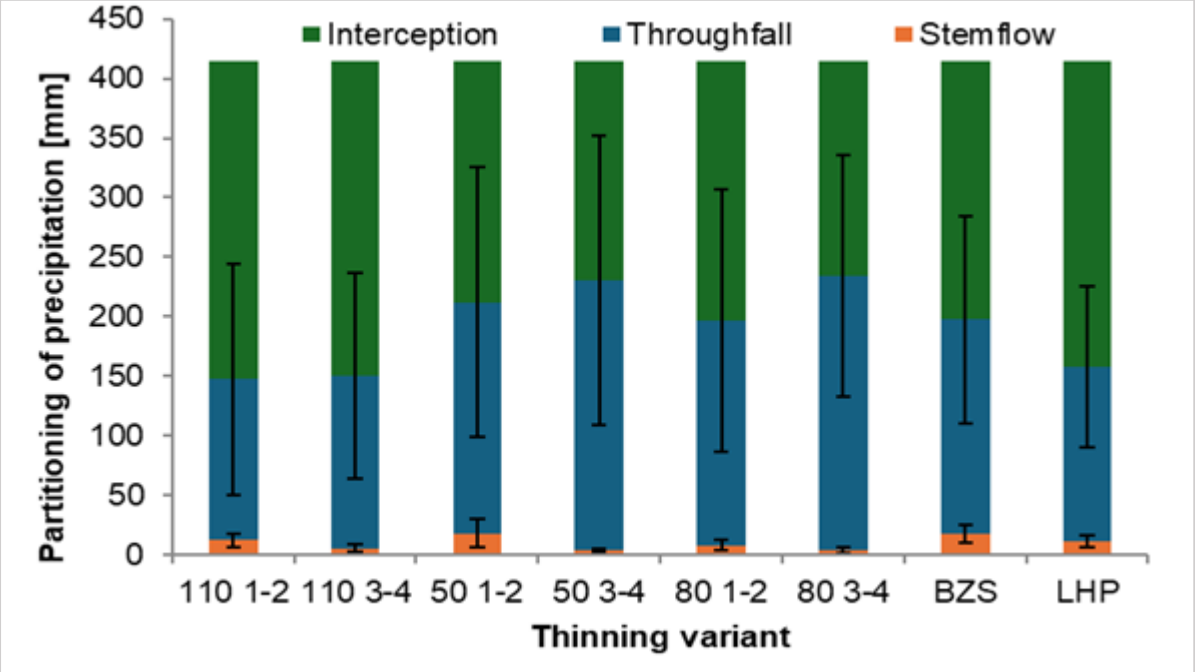

Fig. 1: Rainfall partitioning. The wiskers denote standard deviations.

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NATURAL REGENERATION OF SESSILE OAK (*QUERCUS PETRAEA*) UNDER SHELTERWOOD AND THE INFLUENCE OF COMPETITION FROM OTHER TREE SPECIE

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Keywords: biomass, dendrometric parameters, European beech, European hornbeam, shelterwood

1 INTRODUCTION

The sessile oak (*Quercus petraea*) ranks among the most valuable commercial tree species in Europe (Kanjevac et al., 2021). This species is considered a key component of future mixed forest stands that are expected to help European forests better adapt to ongoing climate change (Kohler et al., 2020). In modern forestry, natural regeneration of stands is increasingly promoted as an essential element of close-to-nature forest management (Vacek et al., 2010). However, the success of natural oak regeneration depends not only on the chosen regeneration method but also on a wide range of biotic and abiotic factors and their interactions. Due to limited understanding of these influences, considerable uncertainty remains regarding optimal silvicultural practices (Kohler et al., 2020). A crucial factor in the initial phase of regeneration is seedling density, as higher numbers can suppress the development of competing vegetation. Among the most common competitors in European forests are beech (*Fagus sylvatica*) and hornbeam (*Carpinus betulus*) (Kanjevac et al., 2021). Seedlings of these species tend to overtop oak due to their faster initial height growth and subsequently outcompete it through greater competitive ability (Govedar et al., 2021; Kohler et al., 2020). The aim of this study was to compare parameters of natural regeneration of sessileoak, european beech, and european hornbeam under the shelterwood.

2 MATERIALS AND METHODS

Within the FTE Křtiny area, three stands were selected for sampling of naturally regenerated seedlings of sessile oak (*Quercus petraea*), European beech (*Fagus sylvatica*), and hornbeam (*Carpinus betulus*). Samples were collected beneath the parent stand. For each variant, 50 individuals were taken, resulting in a total of 150 oak seedlings, 150 beech seedlings, and 126 hornbeam seedlings (at one site, only 26 individuals were collected due to low density). For each sampled individual, total height was measured to the nearest 0.1 cm. Root collar diameter was measured with an accuracy of 0.1 mm. After the measurements, each sample was divided into three main fractions: leaves, stems, and roots, and carefully stored in pre-labeled paper bags. The bags were then placed in a drying oven and dried at 105 °C for 24 hours. After drying, the dry weight of leaves, coarse roots, and stems was determined to the nearest 0.001 g. Based on the obtained data, total dry biomass and the ratio between aboveground and belowground plant parts were calculated.

3 RESULTS

Fig. 1 shows the total height of seedlings. The greatest heights were recorded for hornbeam (EH) seedlings across all three sites, while the lowest values were observed in sessile oak (SO) seedlings. This may be due to the fact that hornbeam generally exhibits a higher growth potential during the early developmental stages and responds more favourably to suitable soil conditions.

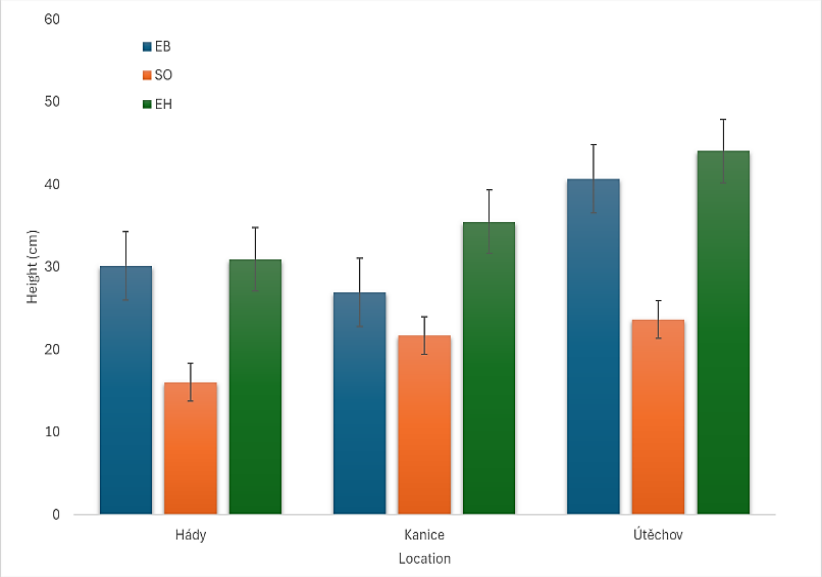

Fig. 3: Total height of natural regeneration in different location

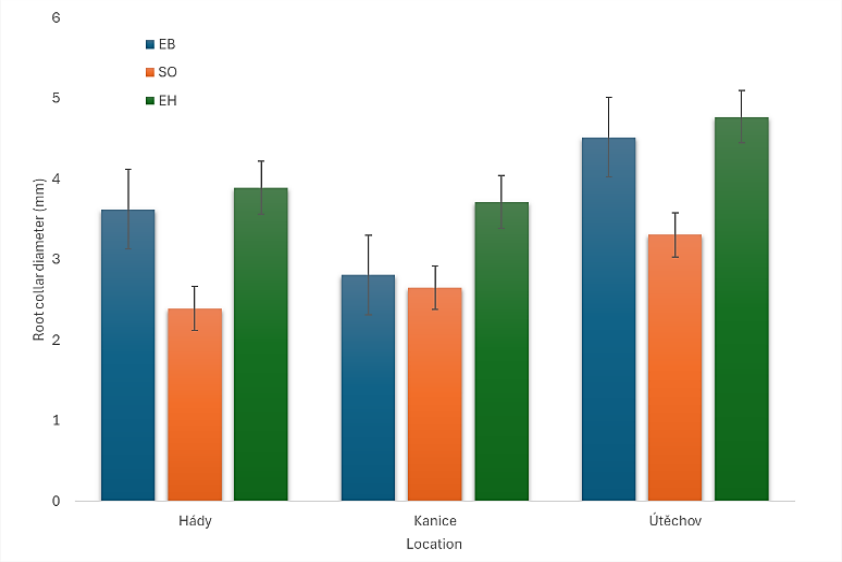

Fig. 4: Root collar diameter in different location

Fig. 2 shows the root collar diameter of seedlings. The largest diameters were recorded in hornbeam (EH) seedlings across all studied sites, while the smallest values were observed in sessile oak (SO) seedlings. These differences may be related to the distinct ecological requirements of the individual species.

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Wood*Net* 2025

NON-DESTRUCTIVE METHODS OF MEASURING SAWLOGS TO ESTIMATE THE PHYSICAL AND MECHANICAL PROPERTIES OF SAWN TIMBER

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Keywords: Norway spruce, sawlog quality sorting, sawn timber grading, wood defects

1 INTRODUCTION

The sawmill industry is the most significant consumer of sawlogs in the Czech Republic. Although new standards for measuring and evaluating logs were introduced in the 2000s, quality grading is still based on visual assessment by an operator based on the presence of defects, with the possibility of automatic detection of only certain defects, such as sweep or taper. There is still great potential for log pre-grading to produce strength-graded sawn timber, which is enhanced by developments in technologies such as computed tomography (Ravoajanahary et al., 2025) or acoustic methods (Rais et al., 2020). The combination of a multiple non-destructive methods also appears to be an interesting option (Weidenhiller et al., 2023). The goal of this work is to define a suitable combination of non-destructive methods for predicting the mechanical properties of sawn timber based on the properties of sawlogs.

2 MATERIALS AND METHODS

Figure 1 shows the different phases of project implementation. In total 60 Norway spruce (*Picea abies* L.) sawlogs were measured and processed.

Fig. 5: Low-quality sawlog III.D (a); Sample with a higher MC = 90.4% (b); Sample with a lower MC = 81.9% (c); High-quality sawlog III.A (d); Measuring area at the Sawmill Olomučany (e); Cant sawing with a resulting 3 central boards (f)

Detection and measurement of wood defects was performed on the sawlogs, with subsequent quality classification according to valid standards (ČSN EN 1309-3, Recommended Rules for Measuring and Grading of Roundwood in the Czech Republic 2008). The first natural frequency in the longitudinal direction and bending was measured on the sawlogs, followed by sampling for moisture content determination and weighing of the sawlogs using hanging scale. The dimensions (diameter, length) were measured manually, and the logs were then transported to the partner National Forest Centre Zvolen for CT scanning. Sawlogs were processed according to the designed sawing pattern with the production of 3 centre boards with dimensions of 50/160/3,000 mm. The acoustic properties of the sawn timber (longitudinal and bending frequency) were measured in three phases – green sawn timber (1), dry sawn timber (2), sawn timber after drying and trimming (3). The trimming was performed so that the area with the worst section was in the middle of a 1.5 meter long piece. The worst area was determined in accordance with the ČSN 73 2824-1 standard. The sawn timber was photographed for subsequent image analysis of the wood defects present. Density, moisture content, MOR parallel to the grain, global and local MOE in bending were measured in accordance with ČSN EN 408+A1.

3 RESULTS

According to preliminary results, the acoustic method allows for accurate prediction of the mechanical properties of sawn timber (Figure 2). On the contrary, visual characteristics are not a suitable predictor of MOR and MOE. In follow-up research, it is appropriate to expand the model with parameters based on the processing of CT scans of sawlogs.

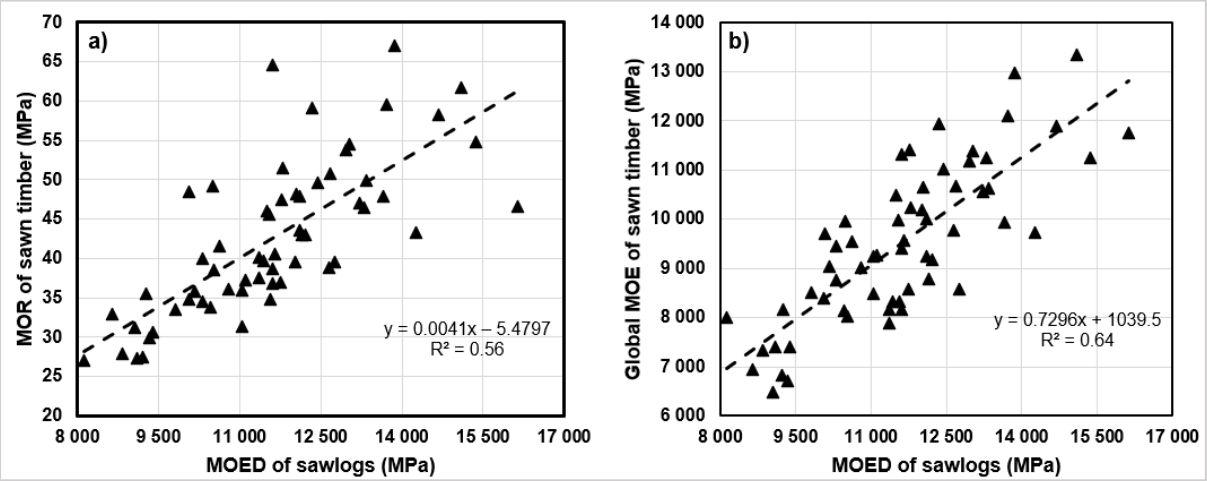

Fig. 6: Relationship between MOED of sawlogs and MOR of sawn timber (a); Relationship between MOED of sawlogs and global MOE of sawn timber (b)

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This study was supported with funding provided by the Internal Grant Agency, Mendel University in Brno, project number IGA25-FFWT-IP-022.

IMPACT OF DIFFERENT TYPES OF TERRAINS AND CARRYING OF THE LOADS ON CHANGES IN WALKING AND MOVEMENT PATTERNS OF THE FORESTRY WORKERS WITH A FOCUS ON POSSIBLE WALKING ACCIDENTS

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Keywords: biomechanics, digital motion capture, forestry environments, gait analysis, human locomotion, inertial measurement units (IMU), slip, trip and fall prevention, terrain-specific mobility

1 INTRODUCTION

Forestry is among the most physically demanding and hazardous professions, with slips, trips, and falls accounting for a substantial proportion of work-related injuries. Irregular terrain typical of forest environments imposes high demands on locomotor control and body balance. Most gait research has been conducted on laboratory surfaces [1,2]. This study aimed to quantify how human gait adapts across three typical terrains relevant to forestry work-solid surface, forest trail, and natural forest environment, and how the structure of movement changes in relation to the carried load that workers have to carry while performing their work activities. We hypothesized that (i) spatiotemporal gait variability and changes in foot-strike patterns would increase with terrain complexity [3,4], and (ii) these adaptations would indicate higher fall risk and reduced dynamic stability [5] in forest environments compared to solid ground.

2 MATERIALS AND METHODS

The study was divided into two parts: examining body behaviours while walking in different environments without and with an additional load, a 10-kilogram weight, which was supposed to simulate carrying a work tool - a chainsaw. A total of 23 subjects participated in the first part of the study of walking without weight, and 15 subjects in the second part (14 men, 9 women; mean age 34 years), without recent musculoskeletal or neurological disorders. Each participant performed walking trials at a self-selected comfortable speed over three outdoor surfaces with controlled length and conditions: (1) a solid, even surface, (2) an unpaved forest trail, and (3) a natural forest environment with roots, stones, and irregular soft soil.

Using 17th wearable Inertial Measurement Units (IMU's - Xsens MVN - consist of accelerometers, gyroscopes, and magnetometers), we digitally recorded and quantified body posture and other risk levels related to movement. Using specific SW applications, we generated gait reports that provided general (e.g., walking speed, cadence, number of steps, walking time, and distance), spatial (step and stride length, step width), temporal (gait cycle timing), and foot-strike parameters (heel vs. toe strikes), together with pelvis and center-of-mass trajectories and ergonomic risk levels which may impact participants bodies.

Statistical analysis included multivariate analysis of variance (MANOVA), follow-up ANOVA, Kruskal–Wallis and simple statistical tools were used to examine the effects

of surface type, walk order, gender, and shoe size, and their interactions, on selected gait and load parameters.

3 RESULTS

Project results showed that the type of surface had a significant effect on walking behaviour. On a solid surface, participants demonstrated stable and efficient walking characterized by regular steps and cadence (19 steps; 102.5 steps min^{-1}), minimal differences in step length - 1.2 cm, a very high proportion of heel strike time during the step (99.7%), and body stability. Variability in step width (+/- 0.6 cm) and step length (+/- 1.9 cm) was minimal, indicating low neuromuscular demands and low risk of accident.

On the forest surface, walking pattern showed measurable adaptations - there was an increase in step number and a decrease in cadence (27.5 steps; 99.6 steps min^{-1}), variability in step width (+/- 2.7 cm), and step length increased (+/- 8 cm). The proportion of heel strike time during the step decreased to (80.1%) with a corresponding increase in toe engagement time (19.9%), indicating a more cautious strategy responding to terrain and less body stability during walking.

The addition of simulated load had a further impact on gait structure and the level of body instability during movement in complicated terrain - there was a decrease in step increment and a decrease in cadence (26.4 steps; 98.7 steps min^{-1}), variability in width (+/- 2.9 cm), and step length increased (+/- 8 cm). The proportion of heel strike time during the stride decreased slightly (79.2%), and the percentage of toe engagement time increased (21.8%). The change in movement regularity with increasing load in correlation to terrain structure became much more irregular and scattered, indicating higher demands on postural control of the body and reduced body stability.

The obtained data support both hypotheses: increasing terrain and load complexity led to significantly greater spatiotemporal variability and altered foot strike patterns, which is consistent with an increased risk of slips, trips, and falls. These findings are important not only for designing proper work procedures and preventive strategies in the field of OSH, but more detailed research on this topic may contribute to the future development, especially to the prevention of injuries of older workers, the design of virtual and augmented reality systems, and the Human Robotics system.

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DEVELOPMENT TRENDS OF SAW CHAINS AND ANALYSIS OF THE FORCES ACTING ON THE SAW CHAIN TOOTH

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Keywords: chain saw, kinematic and dynamic parameters, planing chain link, sharpening angle

1 INTRODUCTION

The project focuses on comparing two types of saw chains: 3/8" Rapid Super chain with standard geometry and the new Stihl Hexa cutting system, which consists of a 3/8" Hexa saw chain and a Hexa file. The quality of the cutting process is directly related to the geometry of the cutting elements of the saw chain, which is why choosing the right one and taking care of it is one of the key requirements. During operation, the chain gradually becomes dull, which reduces the quality of the cut and increases the difficulty of operating the chainsaw.
Stihl has launched the new Stihl Hexa cutting system, which consists of a 3/8" Hexa saw chain and a Hexa file. The manufacturer claims that the cutting performance of the new chain is up to 10 percent higher than the 3/8" Rapid Super chain with standard geometry. This is an unusual innovation compared to the traditional round shape of the saw tooth blade. Materials for saw chains: The steels used for the production of saw chains require a combination of high strength, toughness and wear resistance. This can be achieved by proper heat treatment of iron alloys containing silicon, which is able to form microstructures containing austenite with the required hardness. The cutting surface of the saw teeth is coated with a hard layer of chromium. For special types of chains that are intended for recovery work and cutting e.g. car bodies, the cutting links are supplemented with diamond blades. However, these chains are not used in the woodworking industry, here chains with carbide edges are used for use in more demanding conditions.

2 MATERIALS AND METHODS

In the first part of the project, operational measurements were carried out in the terrain, where both chains processed the same amount of wood and their gradual dulling was monitored under a microscope. The main cutting edge of the saw chain was examined on a Keyence VHX-5000 digital microscope. The raw material processed was Norway spruce (*Picea abies*) and Scotch pine (*Pinus sylvestris*) with bark in 1 m lengths, which were cut into thirds. For each cut, the diameter at the cut points was measured with a forestry caliper and then cut into thirds with a chainsaw. The measurements were taken after consuming 1 tank, which corresponds to 1 hour of work and a cut area of 2.5 m^2. Dulling was measured on 12 cutting links (6 left and 6 right links) selected from the entire length of the chain (every third link in the row). A total of 5 pcs of 3/8" Hexa saw chain and 5 pcs of 3/8" Rapid Super chain were tested.
Parameters such as chain pitch = 3/8"; guide groove width = 0.063"/1.6 mm, n.guide links = 72; tooth profile = edgy and guide bar length = 20"/50 cm are common to both chains. But for Hexa chain are tooth sharpening angle = 25°; file type = hexagen and for Rapid super are tooth sharpening angle = 30°; file type = round ø 5.2 mm.

The second part of the project continues with laboratory measurements, which, unlike operational measurements, also include force measurements. The cutting forces measurement was carried out on the three-axis piezoelectric dynamometer 9257B Kistler. The connection of the measuring apparatus was a laptop with evaluation software DynoWare, an A/D converter DAQ system-data bus type 5697A, a multi-channel amplifier Type 5070A, and a piezoelectric three-axis dynamometer Kistler 9257 B. The sampling frequency of the measurement data recording was set to 4,000 Hz due to the possibility analyze the dynamic course of forces on the cutting edge. It was subsequently processed and further evaluated in DynoWare and MS Excel.

3 RESULTS

The results of increased operational wear show an average of 21% lower values for the Hexa chain compared to the Rapid Super chain. A closer analysis reveals a difference in the median for the left and right links of the Rapid Super saw chain. The left links of this chain show a 38% increase in dullness, while the right links show only a 28% increase compared to the Hexa chain links. In the Hexa chain, the dullness of the left and right links is uniform (average 7.23 µm and median 6.82 µm).

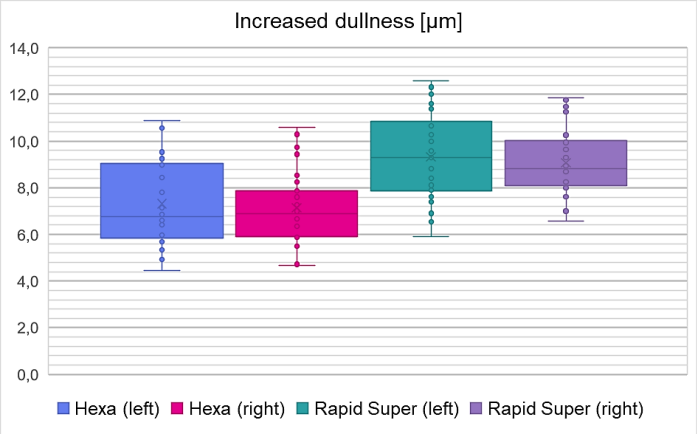

Fig. 1: Increased dullness of the main cutting edge

The lower increase in dullness in the Hexa saw chain links may be due to the different sharpening angle of this chain (25°) compared to the Rapid Super chain. The cleanliness of the processed material is decisive for chain dulling, which could also have caused the higher wear measured on the Rapid Super chain, but given that the same operator worked with the saw under the same conditions and processed the same raw material, this factor can be disregarded. In addition to the factors mentioned above, the cutting performance is also determined by the reduction of the limiting foot, the available power of the saw motor, the chain speed, and the type of wood being processed (Neruda, Nevrkla, Cach, 2013).

4 CONCLUSIONS

The material being processed, the properties of the saw chains, and the skill of the operator will have a particular impact on dullness. Lower dullness increase in Stihl Hexa chains leads to longer cutting performance and thus safer and higher-quality working conditions with lower physical demands on the chainsaw operator.

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ANALYSIS OF ADHESIVE CONTENT ON SELECTED PHYSICAL AND MECHANICAL PROPERTIES OF LSL ELEMENTS MADE FROM BEECH WOOD

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Keywords: bending properties, laminated strand lumber (LSL), MOE, MOR, pMDI adhesive, thickness swelling, water absorption

1 INTRODUCTION

This topic addresses the decline of spruce monocultures in Central European forests due to the influence of bark beetles and climate change (Čermák et al., 2021). Coniferous forests are growing far beyond the boundaries of their natural range; these changes were caused by a loss of biodiversity and decreased resistance (Spiecker, 2003). This fact has a significant influence on the raw material available for the wood-based composite industry. Biological pest damage of this type has dramatically increased in recent decades, which is associated with climate change and air pollution. For these reasons, a shift in forest composition toward increased deciduous species is expected (Hanewinkel et al., 2012). Wooden building construction is increasing in Europe. For this reason, it is necessary to focus on wood-based composites that are suitable for timber construction (Akrami et al., 2014). Laminated Strand Lumber (LSL) is one such wood-based composite, made from strands with a thickness ranging from 0.5 to 2 mm and a length of around 300 mm. It has broad applications in wooden building construction and can be used for rim boards, millwork, windows, and doors (Wang et al., 2015).

2 MATERIALS AND METHODS

Beech and spruce logs were split in half, debarked, and cut into 300 mm long cutouts. The length of the cutouts defines the required length of strands. Strands were manufactured on the laboratory knife ring flaker (MSF 1400, Dieffenbacher-CZ Ltd., Czech Republic). PMDI adhesive was used in amounts of 3.5% or 5% of the strand weight, and a wax emulsion was added at 0.5%. The strands were then separated into three fractions: large strands (retained on a 10 × 10 mm sieve), small strands (retained on a 5 × 5 mm sieve), and dust. Four types of LSL boards were produced: two beech variants with 3.5% and 5% adhesive, and two spruce variants, also with 3.5% and 5% adhesive. These boards were cut into testing specimens with dimensions of 50 × 50 mm, bending specimens of 800 × 75 mm, and compression specimens of 30 × 30 × 105 mm. Bending tests were conducted in two orientations: flatwise and edgewise. These bending specimens were also tested for the dynamic modulus of elasticity. The boards were further evaluated for physical properties, such as thickness swelling and water absorption.

3 RESULTS

The density of the manufactured boards was very similar across all specimens, with no significant differences. The flatness ratio and slenderness ratio were evaluated for both beech and spruce strands. No significant differences were found between the slenderness ratios, but the flatness ratios were significantly higher for beech

strands. A strong correlation was found between the dynamic and static modulus of elasticity. For the flatwise orientation, the correlation was 98.8%, whereas for the edgewise orientation, it was only 40.4%. The lower edgewise correlation may have been influenced by local indentation under the loading heads or supports. The internal bond strength for 5% adhesive content showed no significant differences.

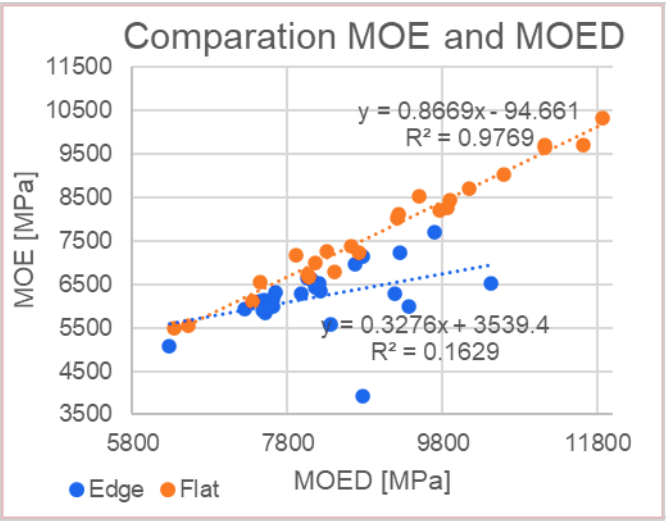

Fig. 1: The relationship between the dynamic and static modulus of elasticity

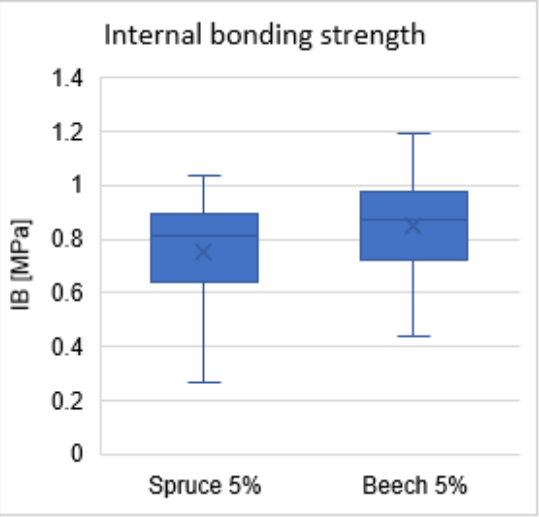

Fig. 2: Internal bonding strength for 5% PMDI

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IMPROVEMENT OF BIOPLASTIC AS AN ADHESIVE

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Keywords: adhesive modifications, biocomposites, eco-friendly adhesives

1 INTRODUCTION

The adhesives that dominate the production of wood composites include amine, phenolic, and isocyanate resins (Liu et al., 2019). Despite their toxicity, phenol-formaldehyde (PF) and urea-formaldehyde (UF) resins still account for approximately 95% of the adhesives used in the production of wood composites, with their global consumption estimated at ~11 million tons per year (Antov et al., 2021). According to Mohanty (2002), sustainability, industrial ecology, eco-efficiency, and green chemistry play a key role in shaping the new generation of materials, products, and processes; the development of innovative bio-based products and technologies that are independent of fossil resources is essential. Since 1990, there has been a significant increase in the number of scientific papers investigating bio-based adhesives for wood-based composite panels (WBCP). In 2000, approximately 60 papers were published on this topic, and in 2022, more than 500. This increase can be attributed primarily to the implementation of new FE regulations worldwide and growing interest in the use of bio-based and renewable products (Calvez et al., 2024).

2 MATERIALS AND METHODS

Samples for lap shear testing were prepared from beech wood in accordance with the ČSN EN 205 standard. These samples were used to test various adhesive mixtures, with a total of 30 types tested. The original adhesive from Weiss (2024) was modified using high molecular weight chitosan from Sigmaaldrich. Chitosan: GymBeam, used as a dietary supplement, was chosen as a second, cheaper option. Silicon Dioxide (SiO_2) Nanopowder was also used to achieve better water resistance of the adhesive. Based on lap shear tests, in which the adhesives were tested after exposure to water, the best variants were selected. These variants were subjected to FTIR (Fourier Transform Infrared Spectroscopy) and TGA (thermogravimetric analysis) tests. The four best adhesive variants were used for the production of particle board. The pressed 600 × 600 × 12mm formats were cut into 290 × 50 × 12 bending samples to determine MOR and MOE. Samples measuring 50 × 50 × 12mm were used to determine IB, WA, and TS. These samples were also used for compostability testing; the composters were manufactured according to a publication by Helen (2021). The change in weight over time was recorded for the samples.

3 RESULTS

All tested adhesives showed 100% failure in the material during lap shear testing in dry conditions. After exposure to water, significant differences in the water resistance of the individual mixtures began to appear. According to the ČSN EN 204 standard, none of the tested adhesives could be classified in category D2, as the best average values achieved after exposure to water were 6.5 N/mm^2.

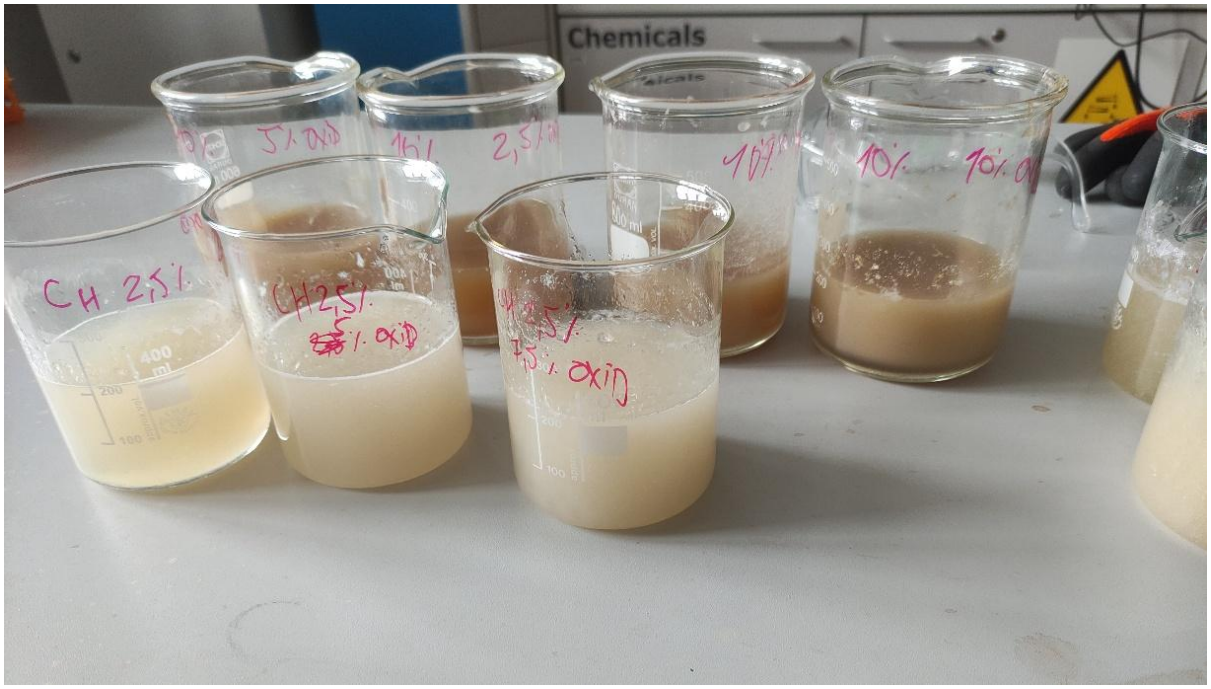

Fig. 1: Examples of individual adhesives.

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