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

Bernatová Martina[1], Michalko Radek[1], Košulič Ondřej[1]

[1]Mendel University in Brno / Faculty of Forestry and Wood Technology

INTRODUCTION

The modern European landscape faces significant ecological challenges due to the widespread use of pesticides for plant protection, leading to various adverse effects both on ecosystems and human health (Bernhardt et al., 2017; Kim et al., 2017). Therefore, reducing pesticide use is crucial to mitigate the risks. By strengthening predator populations, conservation biological control (CBC) aims to harness natural ecosystem processes–specifically trophic cascades–to suppress pests and support plant vitality. In ecosystems worldwide, trophic cascades illustrate how predators can indirectly benefit primary producers by reducing herbivores (Sam et al., 2023; Sivault et al., 2024). However, the majority of natural enemies are generalist and relationships among generalist predators are extremely complex, especially between vertebrate and arthropod predators (Chen et al., 2025), and these complex interactions can significantly influence the effectiveness of pest control (Holland et al., 2016). There can be complementarity among these predators by targeting different pests, but intraguild predation (IGP)–where vertebrate predators (e.g., birds) prey on arthropod predators (e.g., spiders) or arthropod predators prey on each other–can reducing the overall predation pressure on pests. Understanding and managing these dynamic cascades is crucial to optimizing CBC and minimizing the need for chemical pesticides.

AIMS

Our aims were to compare tree physiological vitality indicators and arthropod communities among three different manipulations designed to support arthropod predators and control trees. In addition, we compared two management approaches–the establishment FSs in the interrows and control plots without FSs–within tree nursery environments, to better understand trophic cascades and to identify suitable CBC methods for this type of habitat.

METHODS

In this study, we established eight independent plots, each consisting of a one row of pine trees: four with FSs planted in the interrows and four without, enabling a direct comparison between the two management strategies. Moreover, vertebrate predators were excluded using cages with netting installed around selected trees, while arthropod predator abundance was enhanced by placing cardboard bands on the trunks and branches of selected trees. Tree physiological vitality was assessed using several indicators, including quantification of needle herbivory (dry needle biomass and percentage of needle damage), measurements of relative chlorophyll content (SPAD), and chlorophyll fluorescence parameters–linear electron flow (LEF) and non-photochemical quenching (NPQt)–using a MultispeQ v2.0 device. Measurements were taken three times over the study period. Arthropods were sampled using the beating method (simultaneously with vitality assessments), identified in the laboratory, and analyzed for abundance within functional groups: herbivores (sap-suckers and needle-chewers), predators, and omnivores.

Fig. 1: Study design and methods: (A) manipulations without FSs, (B) manipulations with FSs, (C) measurement with MultispeQ, (D) arthropod sampling by beating (photo by Ondřej Košulič)

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 combination of 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.

CONCLUSION

Because herbivory was lowest in trees with combination of 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 reduce IGP. Other vitality indicators and arthropod abundance are still in progress. Nevertheless, based on the preliminary herbivory results, we suggest that FSs can serve as an effective biocontrol measure, with their efficiency further enhanced by the use of cardboard bands to mitigate IGP and increase predation pressure on pest species in pine nurseries.

REFERENCES

BERNHARDT, E. et al. 2017. Synthetic chemicals as agents of global change. Front. Ecol. Environ. 15(2), 84-90.

CHEN, J. T. et al., 2025. Bottom-up and top-down effects combine to drive predator–prey interactions in a forest biodiversity experiment. J. Anim. Ecol., 94(10), 2035-2046.

HOLLAND, J. et al., 2016. Structure, function and management of semi-natural habitats for conservation biological control: a review of European studies. Pest Manag. Sci., 72(9), 1638-1651.

KIM, K. H. et al., 2017. Exposure to pesticides and the associated human health effects. Sci. Total Environ., 575, 525-535.

SAM, K. et al., 2023. Vertebrates, but not ants, protect rainforest from herbivorous insects across elevations in Papua New Guinea. J. Biogeogr., 50(10), 1803-1816.

SIVAULT, E. et al., 2024. Insectivorous birds and bats outperform ants in the top-down regulation of arthropods across strata of a Japanese temperate forest. J. Anim. Ecol., 93(11), 1622-1638.

ACKNOWLEDGEMENT

We are grateful to the manager of tree nurseries Arboeko in Smržice, namely Martin Prokeš, for allowing us to perform the research in their area. We are very thankful to Marie Matoušková and Josef Urban for their help with chlorophyll content and photosynthesis efficiency analysis, and for lending of instrument MultispeQ v2.0 (for measuring SPAD and chlorophyll fluorescence). This study was supported by the Specific University Research Fund MENDELU (Reg. No. IGA24-FFWT-TP-006).

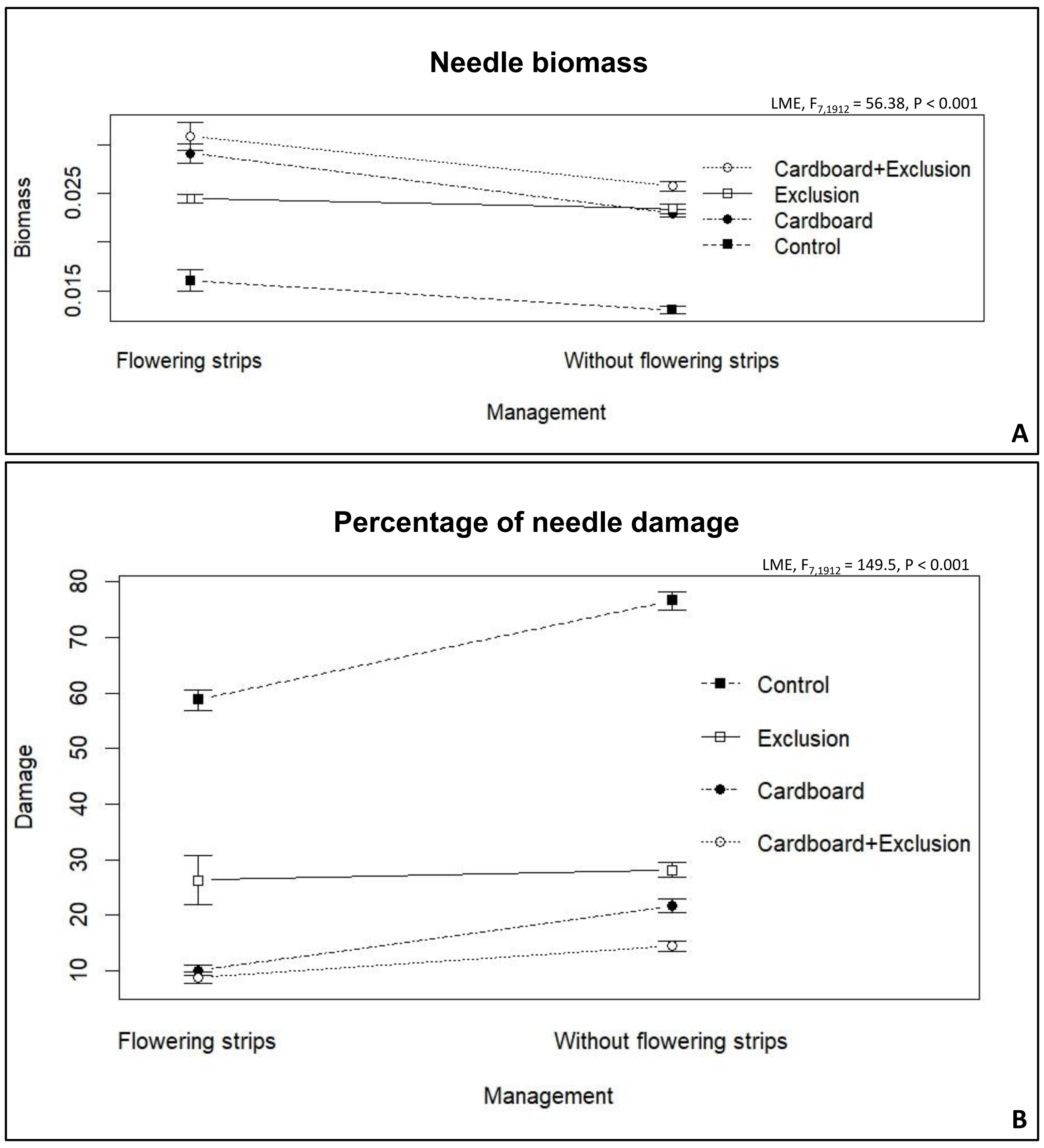

Fig. 2: Tree vitality parameters depended on habitat manipulation and presence or absence of FSs: (A) dry needle biomass, (B) needle damage. Symbols show the mean parameter value for each habitat manipulation for trees with and without FSs in the interrow; error bars represent confidence intervals.

https://www.ldf.mendelu.cz/

MENDELU
Faculty of Forestry
and Wood
Technology