Impact of fertilization on agroforestry system combining rows of wild Cherry and small-leaved Lime with perennial grasses and legumes in Latvia

Andis BĀRDULIS[1], Sarmīte RANCĀNE[2], Mudrīte DAUGAVIETE[1], Santa CELMA[1], Dagnija LAZDIŅA[1]
[1]Latvian State Forest Research Institute "Silava", Rigas str. 111, Salaspils, Lavia, LV-2169; [2]Latvia University of Life Sciences and Technologies, Research Institute of Agronomy, J.Purapukes str. 28, Skriveri, Latvia, LV-5125

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Introduction

The Food and Agriculture Organization (FAO) of the United Nations defines agroforestry as 'land-use systems and technologies where woody perennials are deliberately used on the same land-management units as agricultural crops and/or animals, in some form of spatial arrangement or temporal sequence' (FAO, 2021). Interest in agroforestry as land use practice continues to revive due to it's social, economic, and especially environmental and climate change mitigation benefits. Agroforestry has a high potential to contribute to achieving the EU's biodiversity objectives (e.g., Udawatta et al., 2019) as well as greenhouse gas (GHG) emission reduction target having the ability to sequester atmospheric carbon dioxide (CO_2) in living biomass and soil (e.g., Aertsens et al., 2013; De Stefano, Jacobson, 2017). In Latvia, national legislation that implements international policy and strategical plans does not define agroforestry, so far.

The aim of the study is to 1) demonstrate hemiboreal agroforestry system combining rows of wild Cherry and small-leaved Lime with perennial grasses and legumes in cropland in Latvia and 2) evaluate impact of initial application of different fertilizers including wastewater sludge and by-products of bioenergy production (wood ash and digestate) on tree height as well as on biomass and seed yields of perennial grasses and legumes.

References:

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Methodology

One year old container seedlings of small-leaved Lime (*Tilia cordata* Mill.) and two different clones (No. 10 and No. 13) of wild cherry (*Cerasus avium* (L.) Moench) were planted in agroforestry system (distance between trees was 2.5 x 5.0 m). Between the 5 m tree rows, one legume (*Galega orientalis* Lam. 'Gale') and two perennial grasses cultivars (*Phalaris arundinacea* L. 'Bamse' and *Festulolium pabulare* 'Felina') were sown in 2.5 m wide strips for seed production. In addition, monoculture trials of mentioned herbaceous plants (without tree rows) were sowed for biomass production.

Different types of nutrient and soil buffer capacity compensatory fertilizers including wastewater sludge, renewable energy by-products (stabilized wood ash and digestate from methane reactor) and mineral fertilizers were applied to improve soil quality.

Results

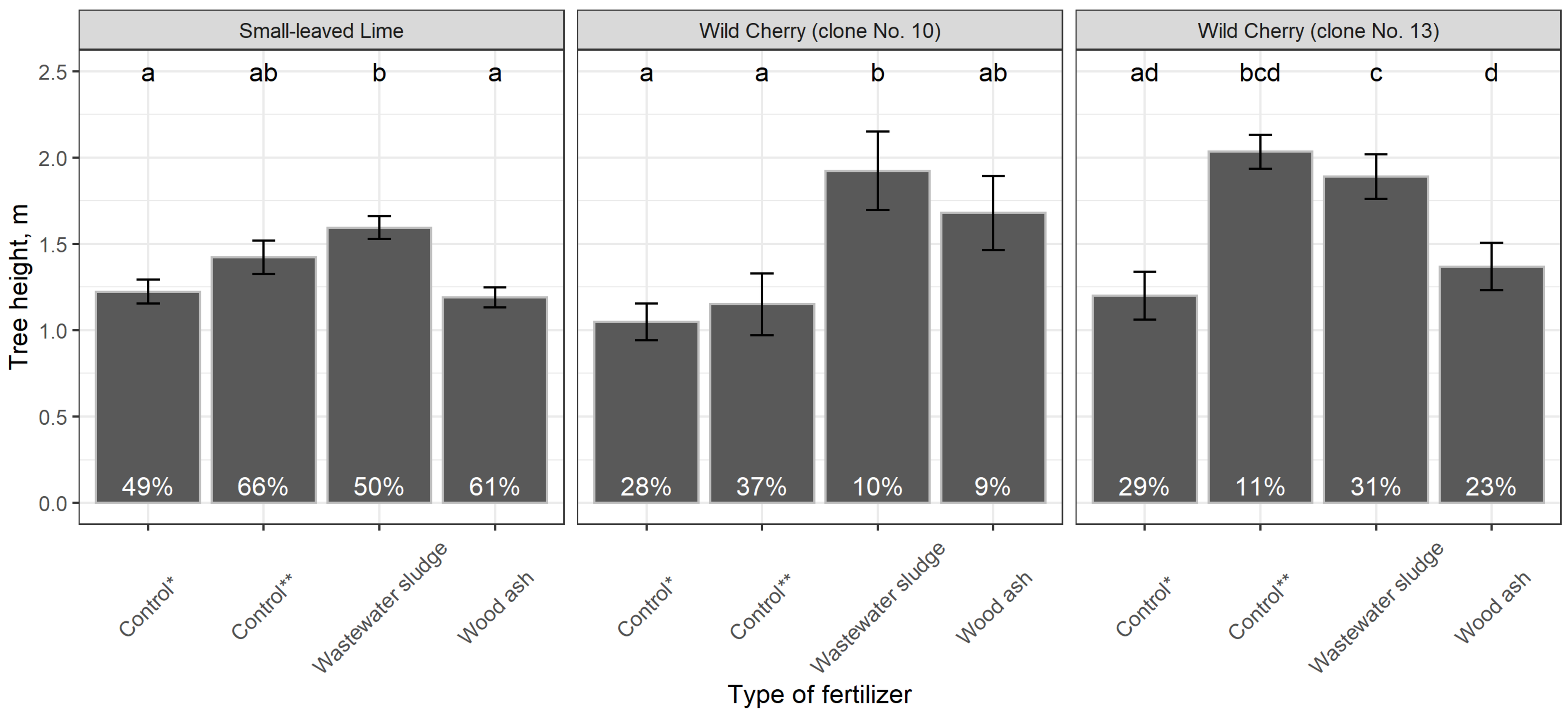

Figure 1. Mean height of wild Cherry and small-leaved Lime after eight growing seasons since tree planting in agroforestry system. White values in the bars show proportion of surviving trees (the proportion of survived trees was relatively very low mostly due to winter frosts and later browsing by hares). Control* – both tree rows and herbaceous plant strips without fertilization; Control** – tree rows without fertilization, but related herbaceous plant strips fertilized with mineral fertilizer. Different letters show statistically significant differences in average values between different fertilizers within the same tree species and clone. Error bars show standard errors.

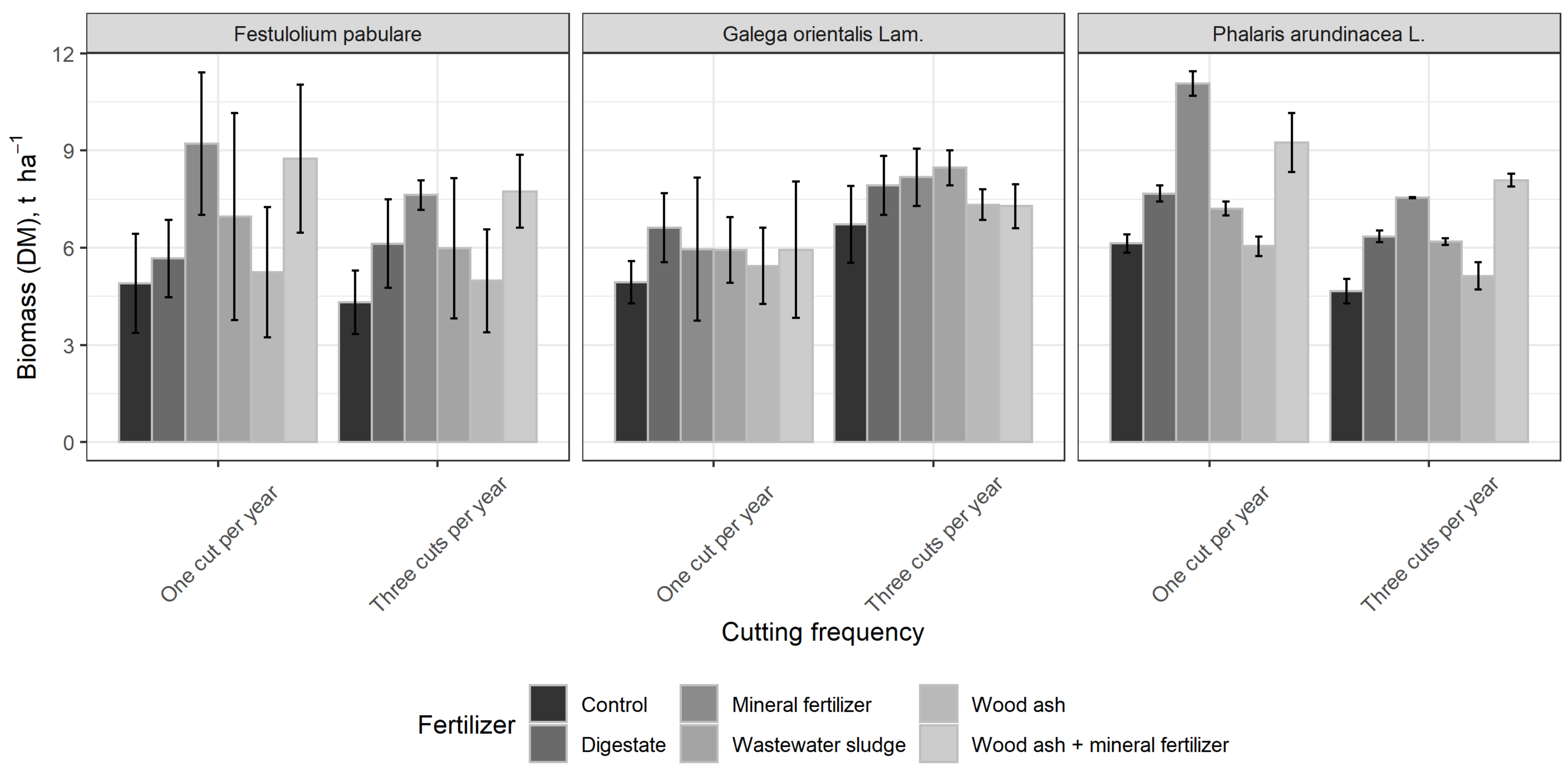

Figure 2. Mean biomass of perennial herbaceous plants in the first and second production year. Error bars show standard errors indicating reliability of the mean values from first and second production year.

Main conclusions

In agroforestry systems combining rows of wild Cherry and small-leaved Lime with perennial herbaceous plants (grasses and legumes), both applied fertilizers and interactions between trees and herbaceous plants had impact on total productivity of the system and thus on the amount of sequestered atmospheric CO_2 in living biomass.

In addition, the use of different type of fertilizers affects chemical composition of biomass. As requirements for the chemical composition of biomass vary depending on its utilization targets, the benefits and risks of fertilization must be assessed on a case-by-case basis depending on the intended use of biomass (for instance, for energy production or forage purposes).