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EVALUATION OF SOIL AMENDMENT EFFECT ON FOLIAR NUTRIENT COMPOSITION AS BASIS FOR DEVELOPING PREDICTIVE TECHNOLOGIES FOR FOREST STAND RESPONSE

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Aim of the study

- to evaluate the short-term effects of NH_4NO_3 and wood ash fertilization on foliar nutrient concentrations in coniferous and deciduous forest stands in Latvia by comparing fertilized and control plots.

The findings provide key nutrient data that can feed into predictive tools — such as forest growth models, remote sensing, and GIS — to support more informed fertilization and forest management decisions.

Materials and methods - study site overview

- 60 forest stands in total:
  - 50 coniferous-dominated (*Pinus sylvestris*, *Picea abies*, *Pinus contorta*)
  - 10 silver birch-dominated (*Betula pendula*)

- Four forest site types:
  - Forests with drained mineral soils
  - Forests with wet mineral soils
  - Forests with drained organic soils
  - Dry upland forests

Materials and methods – fertilizer application

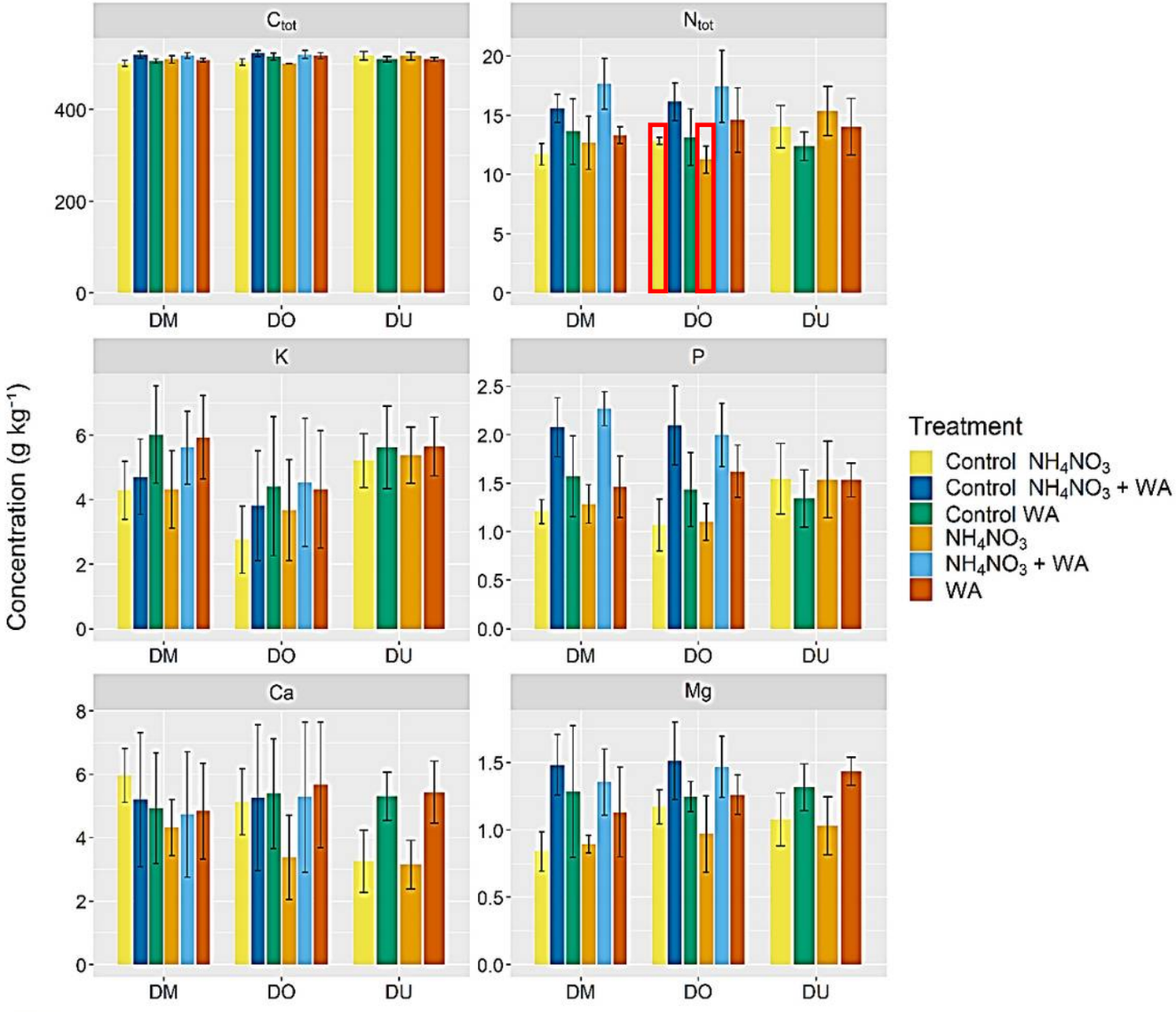
- NH_4NO_3: 0.44 t ha^{-1} (December 2016 – July 2017)
- Wood ash: 3–8 t ha^{-1} (November 2014 – July 2017)
- Treatment combinations:
  - Wood ash + NH_4NO_3: 10 conifer & 6 birch stands
- Application methods: manual or via tractor
- Equipment:
  - Valtra P 191 + Amazone spreader
  - Belarus 952 + conical spreader

Materials and methods - foliar chemical analyses

- Foliar samples were collected 3 - 4 years after fertilization began
- Statistical comparison between control and fertilized plots (Wilcoxon rank-sum test)

Parameter measured	**ISO standard**	**General method description**
Total carbon (C_{tot}) concentration	ISO 10694	Elemental analysis, Elementar EL Cube.
Total nitrogen (N_{tot}) concentration	LVS ISO 13878:1998	Elemental analysis, Elementar EL Cube.
Phosphorus (P) concentration	LVS EN 14672:2006	Spectrophotometry, Shimadzu UV-1900.
Potassium (K), calcium (Ca), magnesium (Mg) concentration	ISO 11466	Flame atomic absorption spectrophotometry, Thermo Fisher Scientific iCE3500

Results – conifer stands

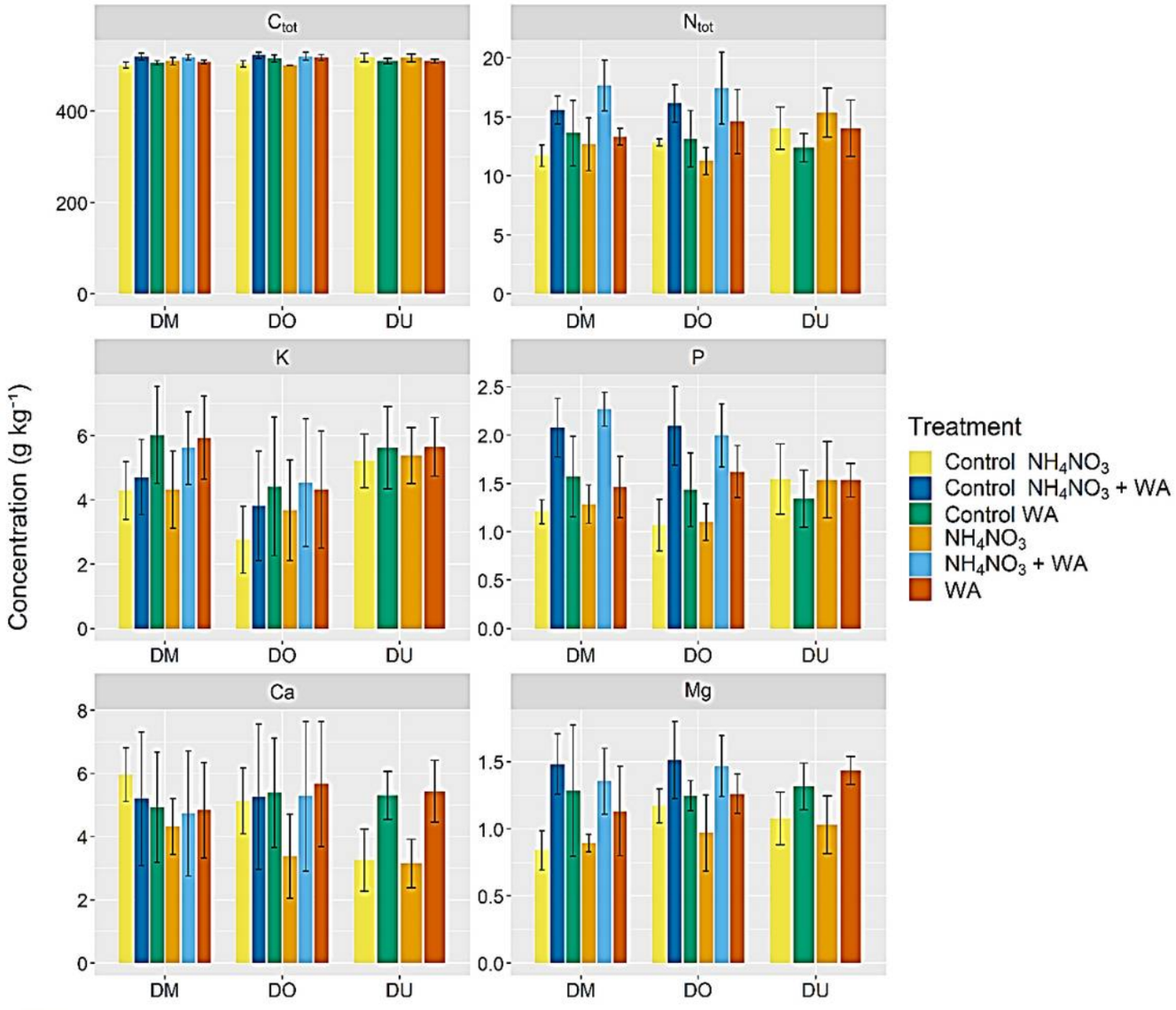


C_{tot}:
No significant differences between control and fertilized plots across treatments or forest site types

N_{tot}:
•NH_4NO_3:
↑ in forests with drained mineral soils and dry upland forests
↓ in forests with drained organic soils (**significant, p = 0.0013**)
→ possible dilution effect
•Wood ash:
↓ in forests with drained mineral soils
↑ in dry upland forests and forests with drained organic soils
Combined (NH_4NO_3 + wood ash):
↑ in forests with drained mineral and organic soils

K:
•↑ with NH_4NO_3 or combined treatments
•Wood ash alone:
↓ in forests with drained mineral and organic soils
↑ in dry upland forests
•Variation likely due to leaching, soil moisture, and site properties

Results – conifer stands



P:

•Wood ash alone:
↑ in forests with drained organic soils and dry upland forests
↓ in forests with drained mineral soils
•NH_4NO_3 + wood ash:
↑ in forests with drained mineral soils
↓ in forests with drained organic soils
•NH_4NO_3 alone: ↑ in all site types

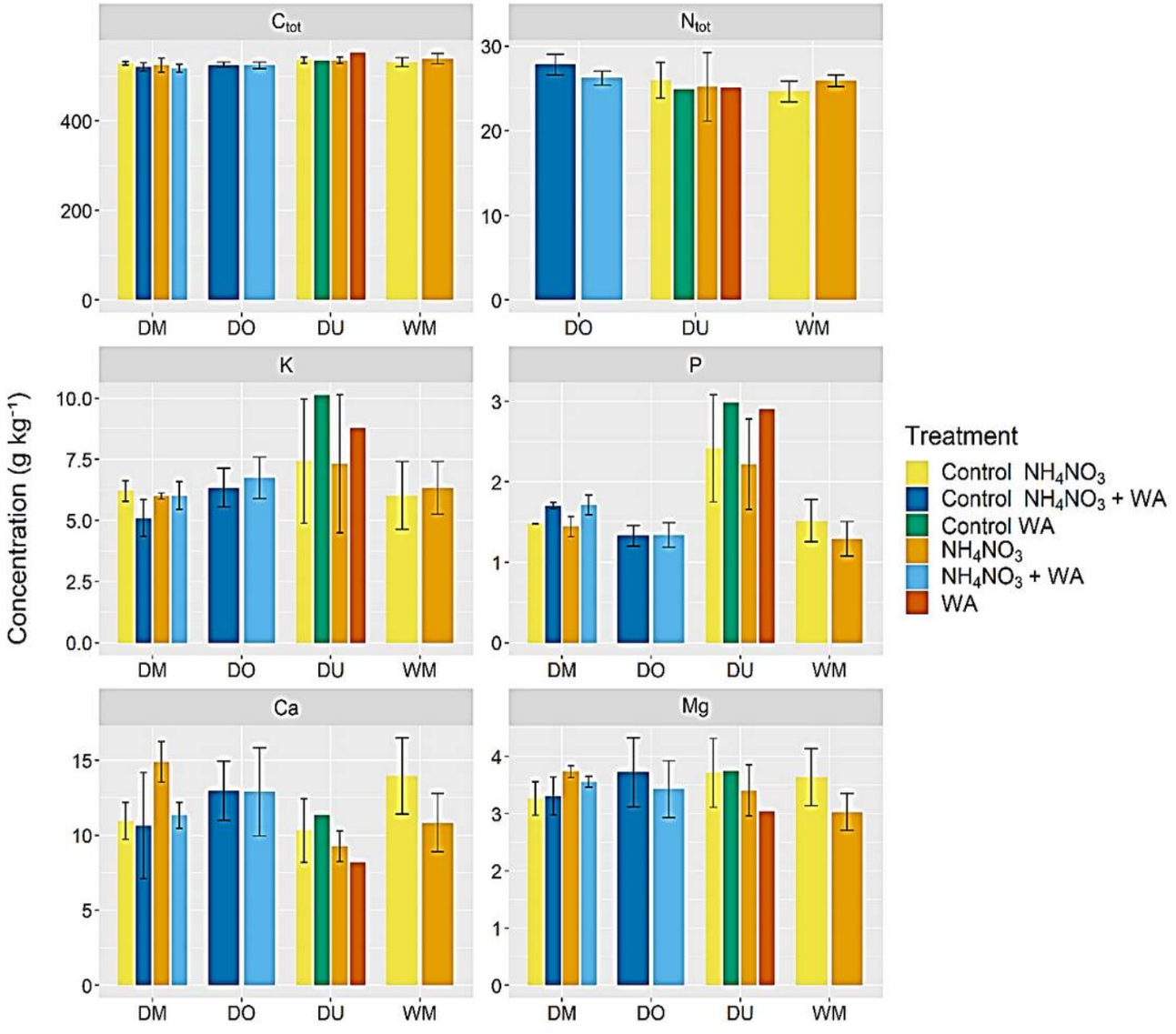
Ca:

•Wood ash alone: ↑ in dry upland forests and forests with drained organic soils
•NH_4NO_3: ↓ across sites (due to NH_4^+–Ca^{2+} competition)
•Combined treatment: slightly ↓

Mg:

•NH_4NO_3 alone:
↓ in dry upland forests and forests with organic soils
Slightly ↑ in forests with drained mineral soils
•Wood ash alone:
↑ in forests with drained organic soils and dry upland
↓ in forests with drained mineral soils
•Combined treatment:
↓ in forests with drained mineral and organic soils
↑ in dry upland forests

Results – deciduous stands

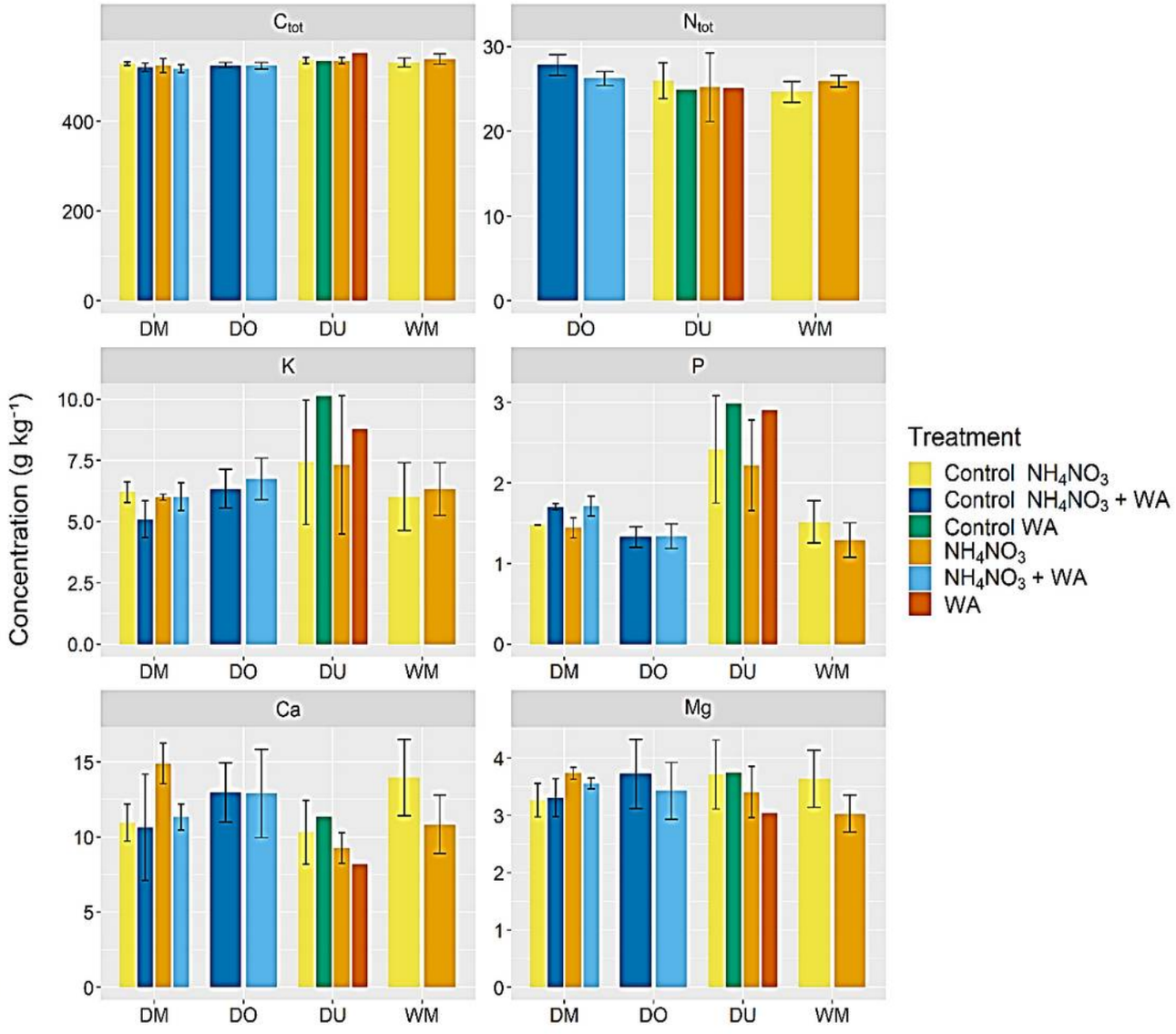


C_{tot}:
No significant differences between control and fertilized plots across treatments or forest site types

N_{tot}:
- Slightly ↑ in forests with wet mineral soils (NH_4NO_3)
- Slightly ↓ in dry upland forests (NH_4NO_3)
- ↓ in forests with drained mineral soils with combined treatment → Possibly due to nutrient competition or dilution effect

K:
- ↑ with NH_4NO_3 + wood ash in forests with drained mineral and organic soils
- ↑ with NH_4NO_3 in forests with wet mineral soils
- ↓ in dry upland forests with wood ash alone
- No effect of NH_4NO_3 alone in dry upland or mineral soils

Results - deciduous stands



P:

- Combined treatment: slightly ↑ (mirroring K)
- Separate applications: ↓ likely due to dilution from biomass increase

Ca:

- ↑ in forests with drained mineral soils with NH_4NO_3 (alone or combined)
- Minimal effect in forests with drained organic soils and dry upland forests

→ Due to cation competition, soil pH, and low Ca input from NH_4NO_3

Mg:

- ↑ only in forests with drained mineral soils
- Minimal response in other site types

→ Likely influenced by leaf traits or limited Mg availability

Conclusions

- Fertilization effects are tree- and site-type specific
- In conifer stands - significantly lower N_{tot} observed in fertilized plots (NH_4NO_3) in forests with drained organic soils → possibly due to nutrient dilution or differences in initial nutrient levels.
- Recommendation: continue long-term monitoring, perform pre-thinning foliar sampling, pay special attention to underrepresented deciduous stands

Thank you for attention!

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