Latvia University of Life Sciences and Technologies

27th Annual International Scientific Conference

RESEARCH FOR RURAL DEVELOPMENT 2021

12-14 May 2021, Jelgava, Latvia

SHORT-TERM EFFECTS OF FERTILIZATION ON PHOTOSYNTHETIC ACTIVITY IN A DECIDUOUS TREE PLANTATION

Guna Petaja, Ilze Kārkliņa, Santa Neimane
LSFRI «Silava»

Introduction

Fertilization is a silvicultural practice to enhance tree growth and timber output. Ammonium nitrate and wood ash are commonly used fertilizers. Most of the tree plantations worldwide are fertilized at some stage of development. Photosynthesis can be defined as the process by which plants use sunlight to synthesize organic compounds from carbon dioxide and water. Variations in this parameter are determinants of plant productivity and studying it can provide useful information on the growth potential of certain tree species and genotypes.

Resarch Aim

The aim of our study was to investigate, how forest fertilization influences leaf-level photosynthetic activity, transpiration and foliar nutrient levels in a deciduous tree plantation.

Materials and Methods

The Keipene plantation is located in the central part of Latvia, Ogre municipality, Keipene parish. Fertilizers were spread manually in 2017. The dosage of NH_4NO_3 was 0.44 t ha^{-1}. In parcels, where decreased tree growth was observed, wood ash was added (3 t ha-1). The element concentration of wood ash was 9.60 g kg^{-1} P, 25.96 g kg^{-1} K., 153.32 g kg^{-1} Ca and 11.58 g kg^{-1} Mg. Photosynthetic activity and transpiration were measured with LCI Compact Portable Photosynthesis System. Additionally, foliar and soil nutrient analyses were carried out.

Results

1. A significantly higher photosynthetic activity was observed only in case of alder hybrid, when wood ash was applied along with ammonium nitrate ($p = 0.0228$, Student's T-test, on average 28.3 ± 4.5 µmol m^{-2} s^{-1} in control parcels and 46.9 ± 2.4 µmol m^{-2} s^{-1} in parcels, where wood ash was spread, Figure 1).

2. Higher values of transpiration were observed only for black alder (3.65 ± 0.45 in control plots and 4.57 ± 0.72 mol m^{-2} s^{-1} in treatment plots). In the rest of the cases in plots, where fertilizers have been applied, the measured values were lower (Figure 2). The differences were not statistically significant.

3. No statistically significant differences in foliar chemistry between control and fertilized plots were found (Table 1). It was expected that wood ash application would avert phosphorus deficiency, resulting in higher photosynthetic activity, however the contrary was observed for hybrid alder. In plots treated with wood ash, phosphorus concentration was the lowest among treatments. One of the possible explanations for increasing photosynthetic activity could be the role of trace elements in photosynthesis, whose levels might have increased after addition of wood ash.

4. No statistically significant correlations were found between leaf nitrogen, leaf carbon and soil parameters (total soil carbon, total soil nitrogen and pH); however, the correlations in most cases were weakly to moderately positive. The increased soil nitrogen content is reflected in increased foliar nitrogen levels, indicating that nitrogen in soil exists in forms available to plants.

Table 1

Foliar nutrient content of fast-growing deciduous tree species and hybrids

Species	Fertilization regimen	N, g kg^{-1}	P, g kg-1	Ca, g kg-1	Mg, g kg^{-1}	K, g kg^{-1}
Black alder	Control	38.0 ± 0.8	3.81± 0.67	11.68± 1.07	3.86 ± 0.19	14.37 ± 0.65
	NH_4NO_3	38.12 ± 1.00	3.67± 0.17	9.97 ± 0.45	3.59 ± 0.15	13.40 ± 0.29
Silver birch	Control	39.47 ± 0.90	3.87± 0.29	7.09 ± 1.07	3.23 ± 0.21	10.21 ± 0.70
	NH_4NO_3	37.42 ± 0.70	3.79± 0.11	7.37 ± 0.79	3.44 ± 0.13	10.08 ± 0.61
Hybrid alder	Control	37.50 ± 0.46	3.598± 0.12	9.95 ± 0.79	2.71 ± 0.28	13.35 ± 0.65
	NH_4NO_3	39.71 ± 1.38	4.050± 0.20	10.38 ± 1.03	3.19 ± 0.23	13.98 ± 0.60
	NH_4NO_3 + wood ash	35.77 ± 1.59	2.97± 0.09	9.89 ± 0.25	3.28 ± 0.23	13.62 ± 0.75
Hybrid aspen	Control	36.46 ± 1.64	4.84± 0.28	13.92 ± 2.16	3.97 ± 0.11	19.51 ± 0.99
	NH_4NO_3	36.66 ± 1.24	4.56± 0.22	10.91 ± 1.01	3.57 ± 0.13	17.58 ± 0.47
Wild cherry	Control	34.50 ± 2.14	4.36± 0.28	14.47 ± 1.76	4.69 ± 0.19	16.29 ± 1.11
	NH_4NO_3 + wood ash	37.56 ± 0.72	4.58± 0.65	19.95 ± 1.85	4.76 ± 0.14	18.22 ± 1.60

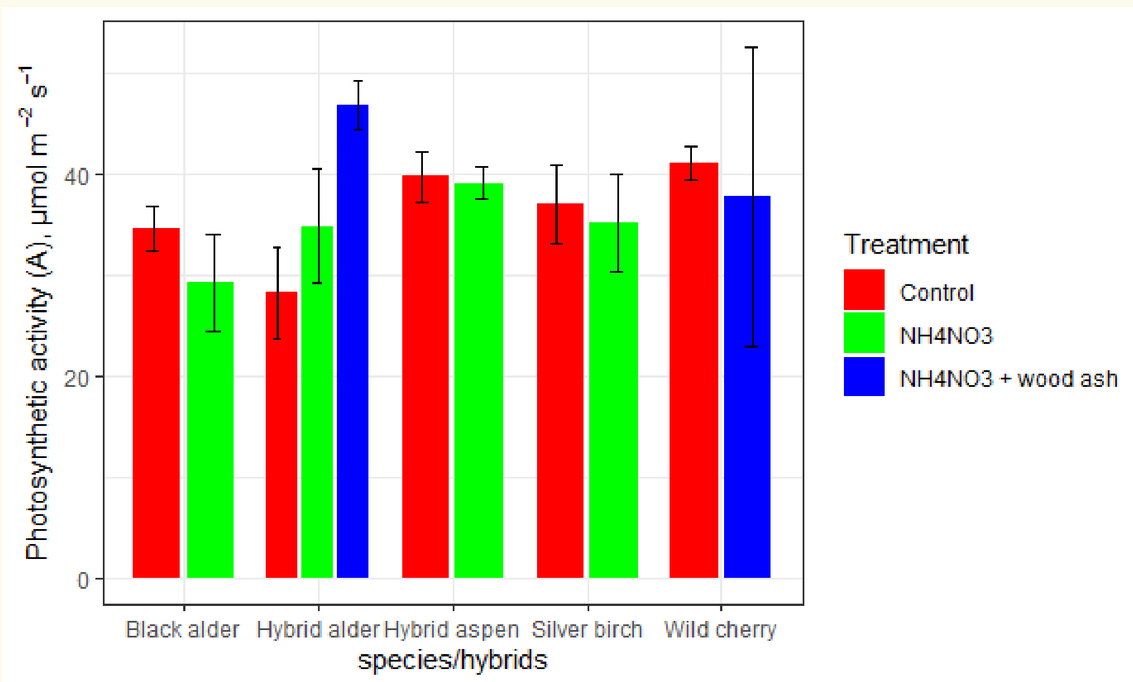

Figure 1. Photosynthetic activity of fast-growing deciduous tree species and hybrids at different fertilization regimens

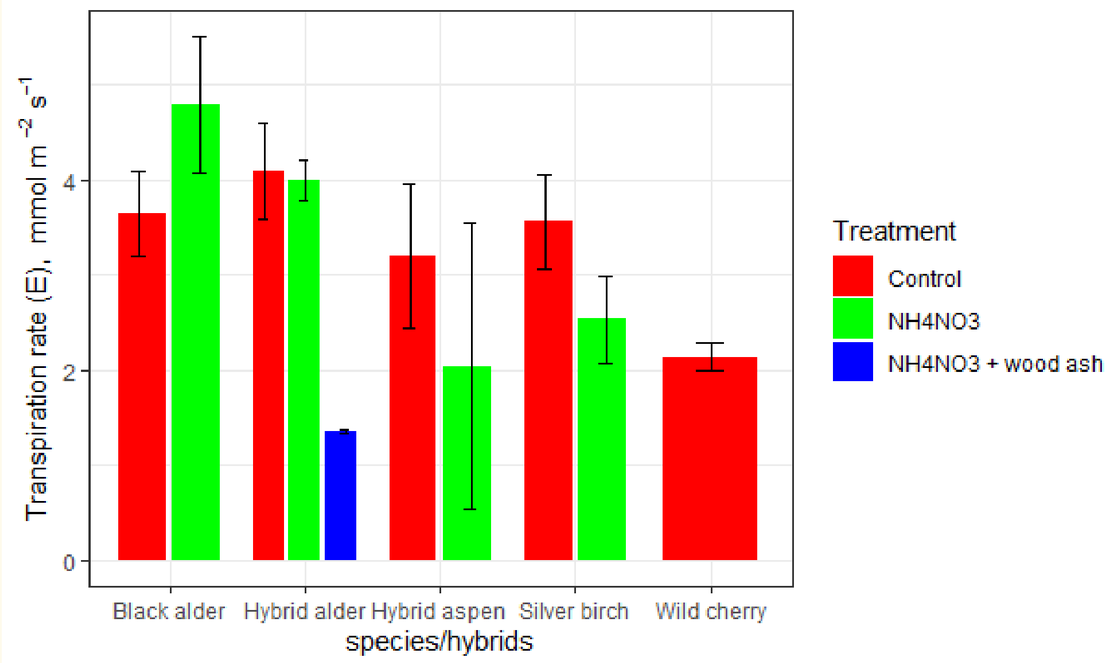

Figure 2. Transpiration of fast-growing deciduous tree species and hybrids at different fertilization regimens

Conclusions

1. The study indicates that nitrogen addition may not result in increased photosynthetic activity. It is also possible that the photosynthetic activity has increased at canopy scale, not at leaf scale. Wood ash addition seems to have resulted in higher photosynthetic activity for hybrid alder, although it could not be explained with phosphorus availability. Levels of other nutrients may have increased after wood ash application.
2. Although the process is closely related to photosynthesis, no impact of fertilization on transpiration was observed. Environmental factors, such as humidity, temperature and wind speed may play a larger role in this process.

Contacts

e-mail of the corresponding author: guna.petaja@silava.lv
Rīga str. 111, Salaspils, LV-2169, Latvia
Phone: +371 67942555, Fax: +371 67901359
e-mail: inst@silava.lv