A Chronosequence Approach to Study Stand Age Effects on Exchangeable K and Ca in the Soils in View of Increased Energetic Utilization of *Quercus* Dominated Forests in Northeastern Austria

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This poster participates in OSP

Outstanding Student Poster Contest

Introduction

The recent IUFRO World Congress Seoul Resolution listed bio-energy as a key thematic areas of scientific research and international collaboration. In view of growing interest in woody biomass as a source of renewable and sustainable energy, a better understanding of soil properties is needed to assess the capacity of the soils for sustainable forest productivity. This study focuses on exchangeable K and Ca pools of soils in order to learn more on the temporal dynamics of plant nutrients as a basis for increased biomass harvesting in northeastern Austria.

Materials and methods

Five permanent *Quercus* dominated sites (Tab 1) were selected for our study. Soil pH, N, C, exchangeable mineral elements K, Ca, Mg, Na, Mn, Al, and Fe were determined in five (0-5 cm, 5-10 cm, 10-20 cm, 20-40cm, 40-50cm) geometric soil horizons.

Table 1 Description of the selected study plots

Plot number	Stand age (year)	Plot size (m)	Species composition	Soil types
S1	11	40*40	*Quercus petraea* with few *Rubus fruticosus*	Eutric cambisol (coarse material ≤ 40%)
S2	32	40*40	*Quercus petraea* with *Galium sylvaticum* in the understory	
S3	50	40*40	*Quercus petraea* with few *Corylus avellana*	
S4	74	40*40	*Quercus petraea* and *Carpinus betulus* with *Galium sylvaticum* in the understory	
S5	91	50*50	*Quercus petraea* with few *Corylus avellana*	

Results

The total pools of exchangeable Mg and Ca in the top 50 cm of the soil range from 882 to 1.652 kg ha^{-1} and 2.661 to 16.510 kg ha^{-1}. Mean value of CEC in different plots ranges from 34 to 107 µmol g $^{-1}$.

Table 2 CEC (µmol g $^{-1}$) at different soil depths. Mean values (n=9) and standard error. Letters indicate significant difference ($p < 0.05$).

Forest	CEC (µmol g^{-1}) in Different Soil Depth					
Site	0-5 cm	5-10 cm	10-20 cm	20-40 cm	40-50 cm	0-50 cm
S1	92 ± 9.8a	45 ± 5.9a	34 ± 2.8a	38 ± 6.0a	57 ± 10.0a	53±4.5a
S2	90 ± 4.9a	59 ± 4.0ab	53 ± 5.8b	63 ± 7.3b	77 ± 7.2a	68±3.3ab
S3	107 ± 9.3ab	86 ± 12.7c	81 ± 13.9c	80 ± 13.3bcd	78 ± 12.6ab	86±5.6bcd
S4	88 ± 10.4a	62 ± 7.9b	52 ± 6.5b	66 ± 11.4b	95 ± 15.4abc	72±5.2abc
S5	95 ± 8.5a	61 ± 6.3b	55 ± 7.1b	69 ± 13.9bc	83 ± 19.1abc	73±5.6abc

Nutrient pools in above ground biomass were calculated by using data from several recent studies and reports.

Table 3 Bivariate correlation Person Coefficients between exchangeable K and Ca, stand age and soil N, C, pH, CEC, K and Ca in aboveground biomass. Age class: rapid growing period (0-40 years); stable growing period (40-80 years); degrading period (>80 years). (**. P<0.01; *. P<0.05)

	Exchangeable K	Exchangeable Ca	Age class
Stand age	0.054	**0.192****	
Soil N	**0.360****	**0.338****	0.12
Soil C	**0.152***	**0.209****	-0.02
Soil pH	**0.382****	**0.643****	**0.135***
CEC	**0.404****	**0.607****	**0.170***
Aboveground biomass K	0.104	**0.134***	**0.521****
Aboveground biomass Ca	0.103	**0.154***	**0.607****

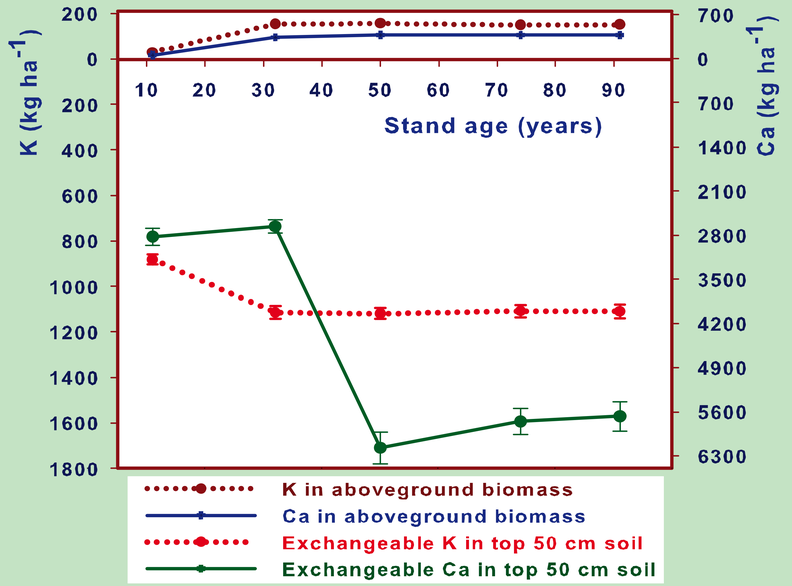

Fig 1 Dynamic K and Ca pools corresponding with stand age. Mean values (n=9) and standard error bar for mineral soil.

There is no correlation between stand age and exchangeable K, soil N and C. The changing mineral nutrient demand during forest stand growth is not reflected in soil nutrient status.

Conclusions

- Soil type, depth and pH are the most important factors to influence the mineral nutrients and CEC.
- Stand age had no significant influence on mineral nutrient levels in the soil.
- The levels of mineral soil nutrients in particular of exchangeable cations are reasonably high and sufficient to support the tree growth under current silvicultural practices and biomass extraction rates.