Phosphorus sorption kinetics in short rotation coppices of *Robinia pseudoacacia* L. on marginal post-mining areas in northeast Germany

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Introduction

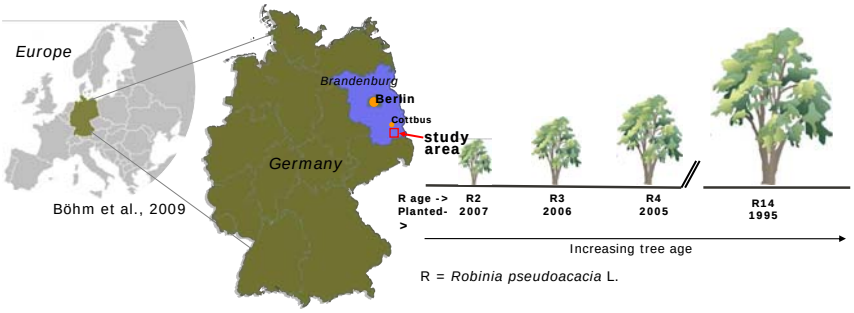
In Germany, the establishment of short rotation coppices (SRC) for production of woody chips for bioenergy increased considerably during the last years. In recultivation of mining sites one of the widely used fast growing tree species is black locust (*Robinia pseudoacacia* L.). As a fast growing tree it can be used for biomass and bioenergy production as well as can improve soil quality. The phosphorus (P) dynamics in new *R. pseudoacacia* forest stands would be a reletionship between the tree's ability to extract P from soil and the soil's ability to supply P in bioavailable form. Phosphorus sorption is one of the most important soil chemical processes. P sorption determinates the quantity of P retained in soil and hence its availability for plants (Barrow, 1983; Van der Zee et al., 1988). The P sorption in soils is mainly influenced by the (hydro)oxide of Fe and Al components (Beek, 1979; Borggaard et al., 1990; Freese et al., 1992; Parfitt, 1989; Van Der Zee and Van Riemsdijk, 1986).

Objectives

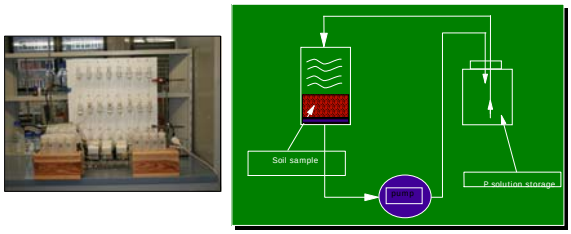
- Evaluate the influence of short rotation tree plantation using *R. pseudoacacia* on the P sorption capacities in post lignite mining soils
- Determine contents of total soil organic P under different ages of *R. pseudoacacia* and it contribution to enhance the soil quality
- Characterize plant available P under different in ages *R. pseudoacacia* forest stands

Material & Methods

***Location of study site in Brandenburg state (Germany)* in post lignite mining soils**

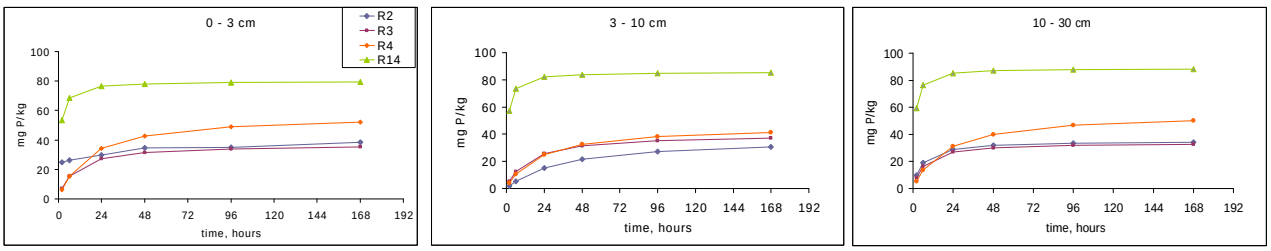


Flow-through reactor method: Experimental setup closed loop with P solution in a storage vessel for sorption studies



- Adsorption was measured for different reaction time: 2h, 6h, 24h, 48h, 96h, 168h
- Initial P concentration: 5 mmol dm^3
- The flow rates: the first 2h -> 2.15mL min^{-1}, and 1.14mL min^{-1} for the remainder duration of the experiment.
- The P equilibrium concentration was measured from the differences between the initial concentration of P and the finial P concentration.
- The difference between the initial and finial P concentration at equilibrium was assumed to be sorbed to the material.
- The Langmuir isotherm was used to describe the sorption equilibrium data.

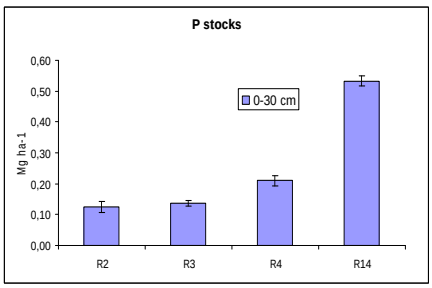
Results



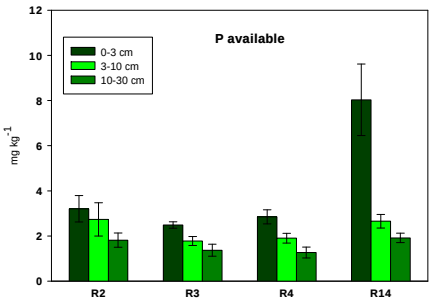
R2: 2-y-old Robinia
R3: 3-y-old Robinia
R4: 4-y-old Robinia
R14: 14-y-old Robinia

Fig. 1 Kineticts of the adsorption process of P on reclaimed lignite soils under *R. pseudoacacia* plantations of different ages (n=6)

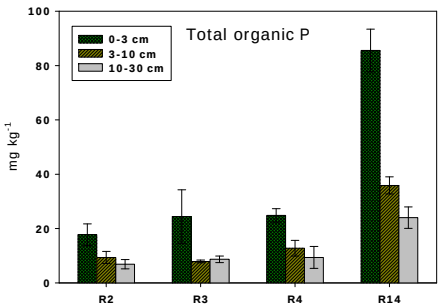
- The quantity of P sorbed by soils increase with increasing time.
- The adsorptions of ions is very rapid in first hours, equilibrium was reached after 72 h.
- The P sorption capacities were higher in the top soil.
- The oldest site R14 showed the highest sorption capacity, removing ca. 80 mg P kg^{-1} and the lowest sorption was found for the R2/R3 site ca. 25 mg P kg^{-1}



- P stocks - increased with increasing tree age
- The highest content was found in the R14 site, avarage -> 530 kg ha-1, however it was 2 times lower then under soils for agricuture use.



- The forms of available P increased with age of Robinia trees, which are capable of maintaining larger fractions of available P in the oldest forest stand.
- However, R2 shows a higher content than R3 and R4, this can be due to short time after fertilizer application.



- The total organic P showed significant effects of Robinia trees age and depths.
- The highest value was in the oldest Robinia stand and the organic P was decreasing with depth.
- The organic P content under R14 was comparable with monoculture pine forest stands (102-y-old) (Slazak et al. 2009) only in topsoil layer.

Conclusions

- The amount of Porg in the soil increased with incresing age of *R. pseudoacacia* suggesting that 14 years of cultivation in post mining sites have a positive influence on the dynamics of organic P in the nutrient pure soil.
- The increasing age promoted an increase in the available P, where the largest fraction was in the oldest stand. However, the amounts of available P were very low compared to the recommended amounts in soils for normal plant growth.
- P sorption capacities showed the highest results for the oldest *R. pseudoacacia* site.
- Maximum P sorbed (Qmax) was found to be linearly related to the sum of oxalate-extractable Fe and Al in all soil layers. The results confirms that Fe and Al oxides mainly influence the soil P sorption capacities.