FIRST SYMPOSIUM ON HORTICULTURE IN EUROPE, 17 – 20 February 2008, University of Vienna - Biozentrum

The ornamental tree *Picea glauca* 'Conica' as a model plant for uptake studies with the environmental pollutant trinitroluene

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Introduction

Most of German former military sites (2.8% of the entire territory) are covered by woodlands dominated by conifers. On large areas of these sites soils are contaminated with explosive's residues, mainly with 2,4,6-trinitrotoluene (TNT). To explore the decontamination potential of conifers with radioanalytical methods, model plants are needed which show all features of adult trees. The dwarf mutant of Canadian white spruce, *Picea glauca* 'Conica' combines low space requirements with easy handling. Therefore *Picea glauca* 'Conica' is suited for uptake studies with [^{14}C]-radio-labelled TNT using glass fibre wick application systems for precisely quantifiable input of water-solved, bioavailable TNT to soil/tree systems.

Methods

Using glass fibre application systems the time course of input of water-solved, bioavailable pollutants (TNT) to the soil/tree system is precisely quantifiable (Schoenmuth & Pestemer, 2004).

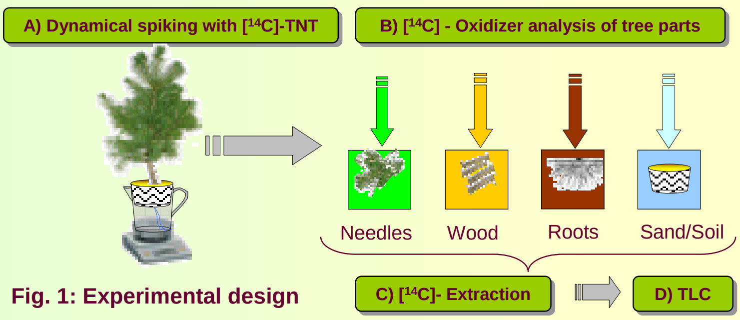

Fig. 1: Experimental design

For uptake studies, uniform ring-labelled [^{14}C]-TNT was pulse-applied via glass fibre wicks. After subsequent "metabolisation time" of five weeks overall radioactivity of tree compartments was determined. Extractability of radio-labelled explosives from plant tissues was estimated by Liquid Scintillation Counting. Radio-labelled extracts were separated by radio thin layer chromatography (TLC).

Results & Discussion

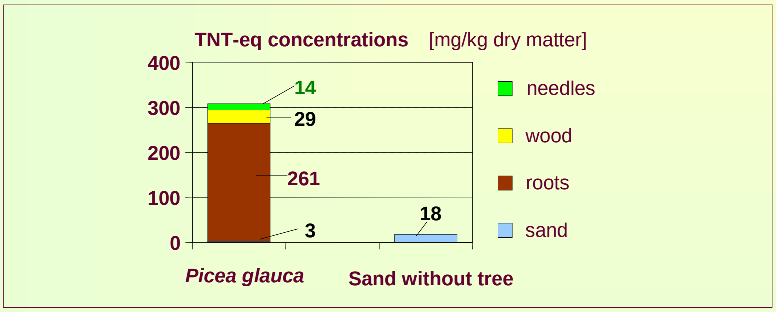

Fig. 2: Morphological compartimentalisation of ^{14}C-uptake

TNT is accumulated in Canadian white spruces. For TNT, highest concentrations of [^{14}C]-TNT equivalents (eq) are found in roots (Fig. 2). Only a very small percentage is transported to above-ground tree compartments, i.e. wood (3%) and needles (2%).

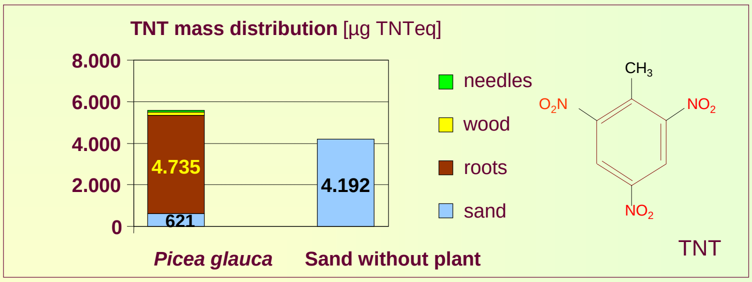

Fig. 3: Reduction of content of soil explosives by *Picea glauca*

The mass distribution of radio-labelled compounds shows that spruces are able to reduce the content of [^{14}C]-TNT in soil. Substrates containing conifer plants clearly indicate less contents of explosive equivalents than unplanted variants.

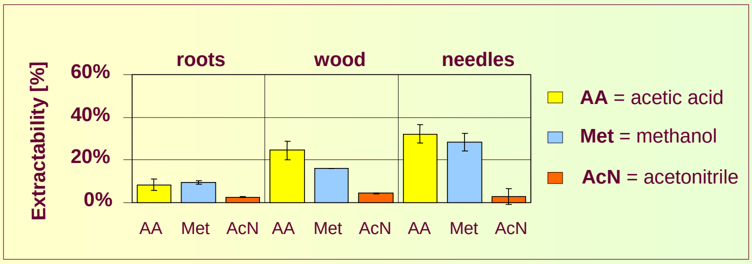

Fig. 4: Extraction efficiency is low for [^{14}C]-TNT in *Picea glauca* roots

Extractability of TNTeq was very low in roots (10%) but higher in wood (25 - 30%) and highest in needles (30 - 40%). The bulk of TNTeq is non-extractable bound in root tissue and only very low amounts of metabolites are translocated to above-ground tree parts.

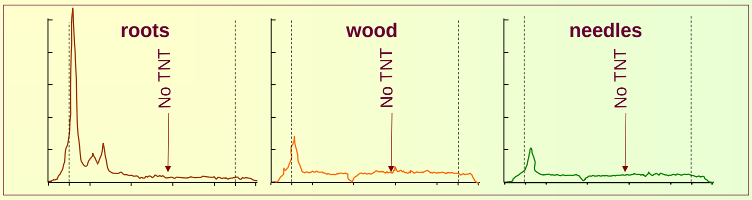

Fig. 5: Radio TLC analysis of ^{14}C extracts from *Picea*

Radio TLC analysis of acetic acid extracts indicates that extractable TNTeq residual portions contain neither TNT nor known metabolites (e.g. ADNTs, DANTs), but TNT is metabolised to polar metabolites.

Conclusions

[^{14}C]-TNT uptake experiments with *Picea glauca* show that conifers are excellent helper components to reduce the content of TNT in contaminated coniferous forest soils.
Their "dendroremediation" potential opens a wide range of future sustainable sanitation possibilities for explosive contaminated areas.

Reference

Schoenmuth B W; Pestemer W (2004). Dendroremediation of trinitrotoluene (TNT). Part 2: Fate of radio-labelled TNT in trees. *Environmental Science & Pollution Research* **11**, 331-339.

BMBF – Funding Priority: „Retention and Degradation Processes to Reduce Contaminants in Groundwater and Soil", Thematic Network 5: „Explosives", Associated Part Project A1 „Dendrotolerance to explosive specific substances in soils and long-term fate of [^{14}C]-trinitrotoluene and [^{14}C]-RDX in coniferous trees.", Grant No. 033 07 04

KORA

Bundesministerium für Bildung und Forschung