Degradation of aged creosote and diesel contaminated soils by phytoremediation

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1. Introduction

Creosote

- Heavy-duty wood preservation compounds for railway ties, bridge timbers, pilling and large-sized lumber.
- Consisting mainly of Polycyclic Aromatic Hydrocarbons (PAHs)
- Released to water and soil mainly as a result of the wood preservation.
- Can move through the soil to the groundwater where it is degraded very slowly.

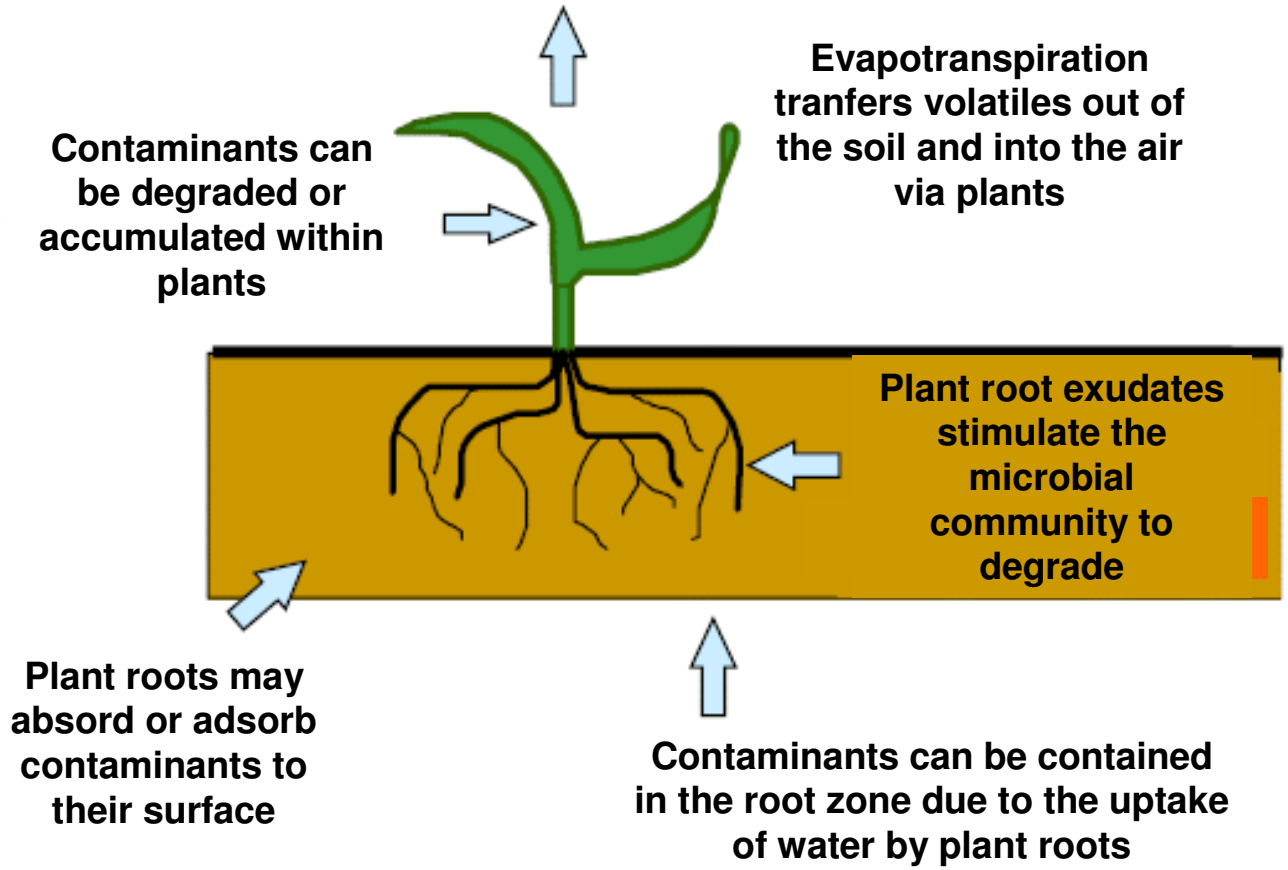
PAHs

- PAHs: Organic compounds with two or more fused benzene rings, arranged in a linear, angular or cluster fashion.
- Residence time is based on chemical structure (e.g. molecular weight), concentration, dispersion, environmental physical properties, and the presence of microbes.
- Low bioavailability
- Toxic and carcinogenic
- Sources of PAHs: Ubiquitous
  - Anthropogenic (former wood treatments or gas work)
  - Natural Sources (e.g. volcanic eruptions and forest fires)

Diesel

- Produced from petroleum.
- Composed of about 75% saturated aliphatic hydrocarbons and 25% aromatic hydrocarbons.
- Lost by both abiotic and biotic processes.
- Very suitable as substrates for microorganisms since they are widely and readily utilized hydrocarbons.

Phytoremediation mechanisms



2. Objectives

- To compare five different willow clones regarding growth and degradation of PAHs (and diesel)
- To investigate effects of nutrients on degradation of PAHs (and diesel)

3. Materials and methods

- Soil: from Hovgården, 15 km outside Uppsala (originated from urban site, Resecentrum and contaminated by creosote and diesel.

- Plant material: five willow clones: Tora, Björn, 78183, Orm and 78112

- Nutrients: Blomstra (trade name, liquid fertilizer)

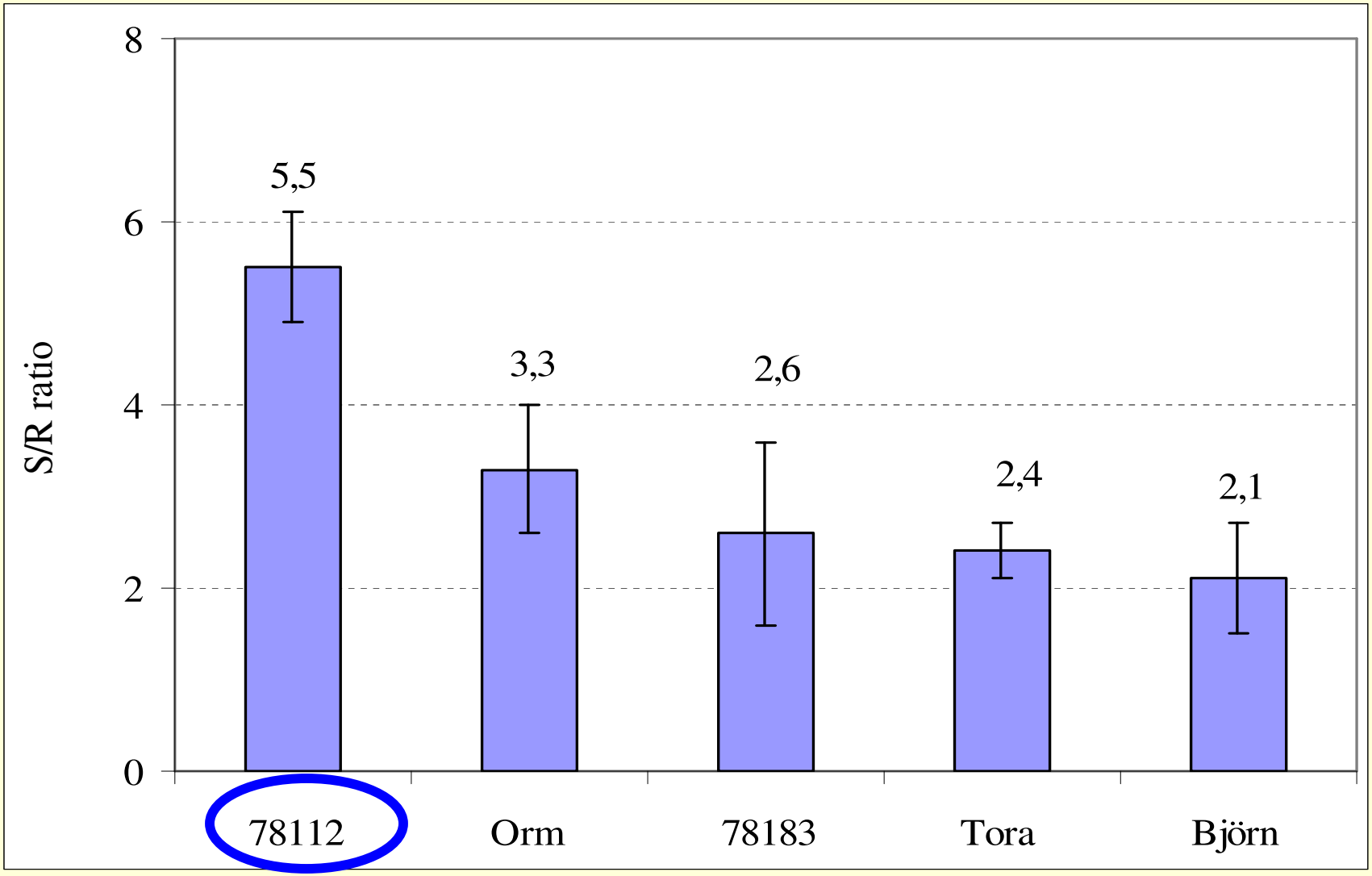
- Contaminated soil
- Mixed soil (1:1)
- Uncontaminated soil

+ 5 Salix clones with nutrients

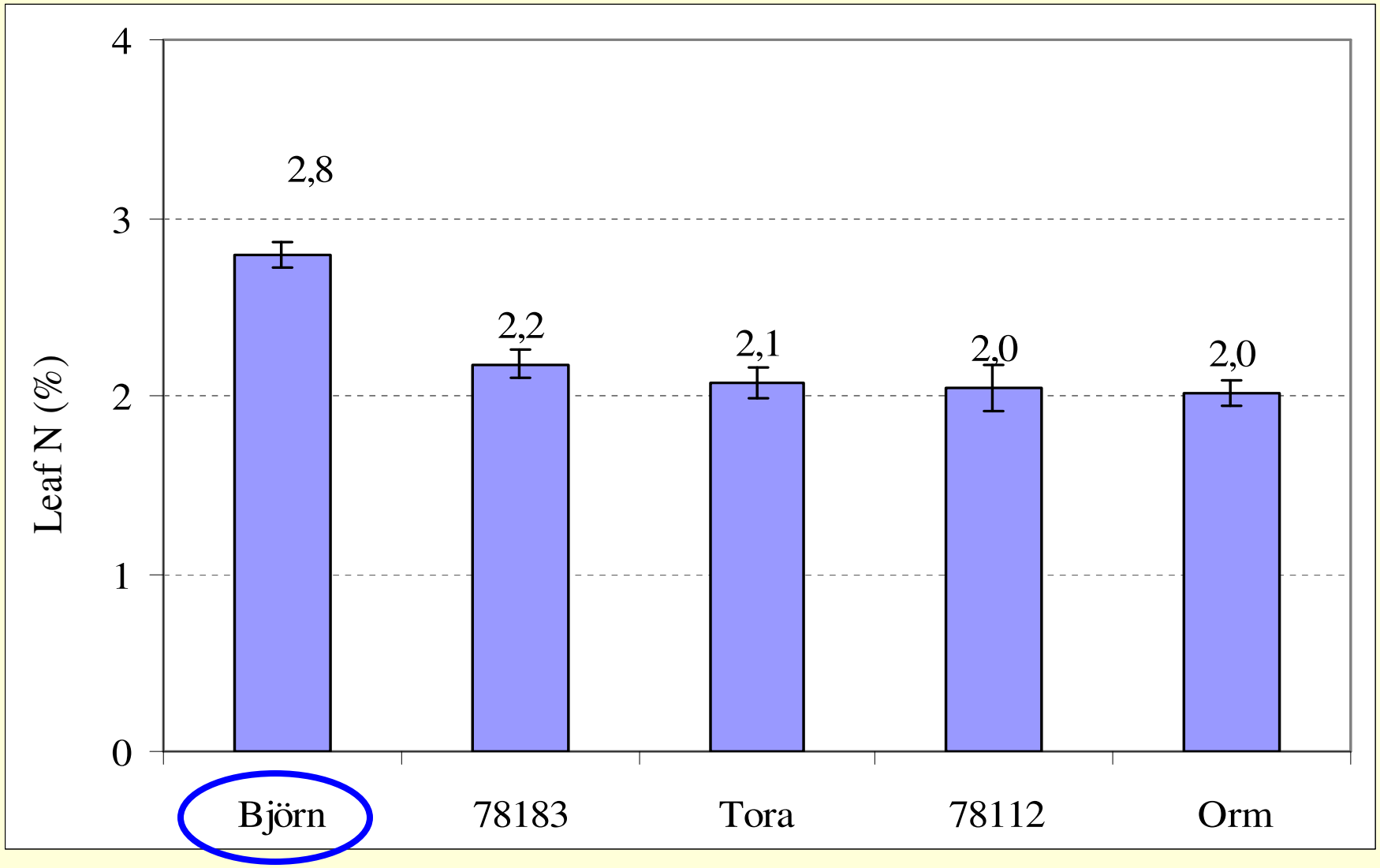
(4 replicates for each clone)

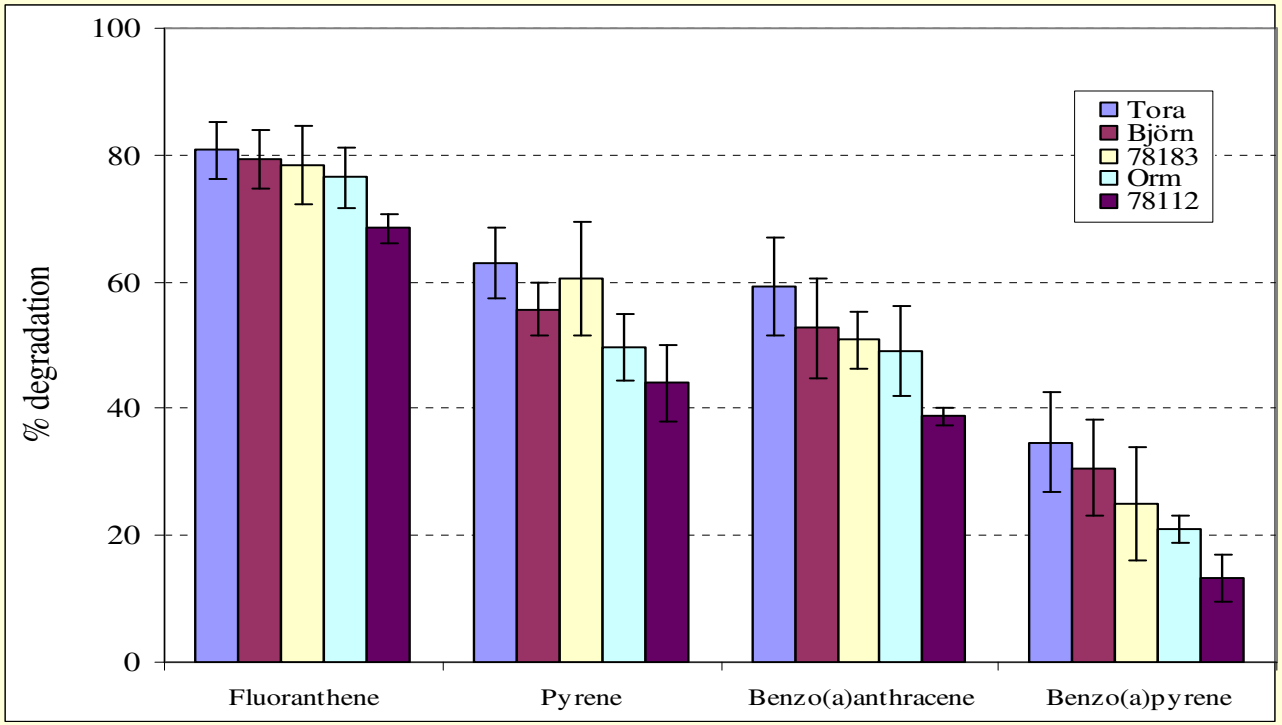
+ no plants with and without nutrients (2 replicates)

Shoot/Root ratio of plants in creosote soil



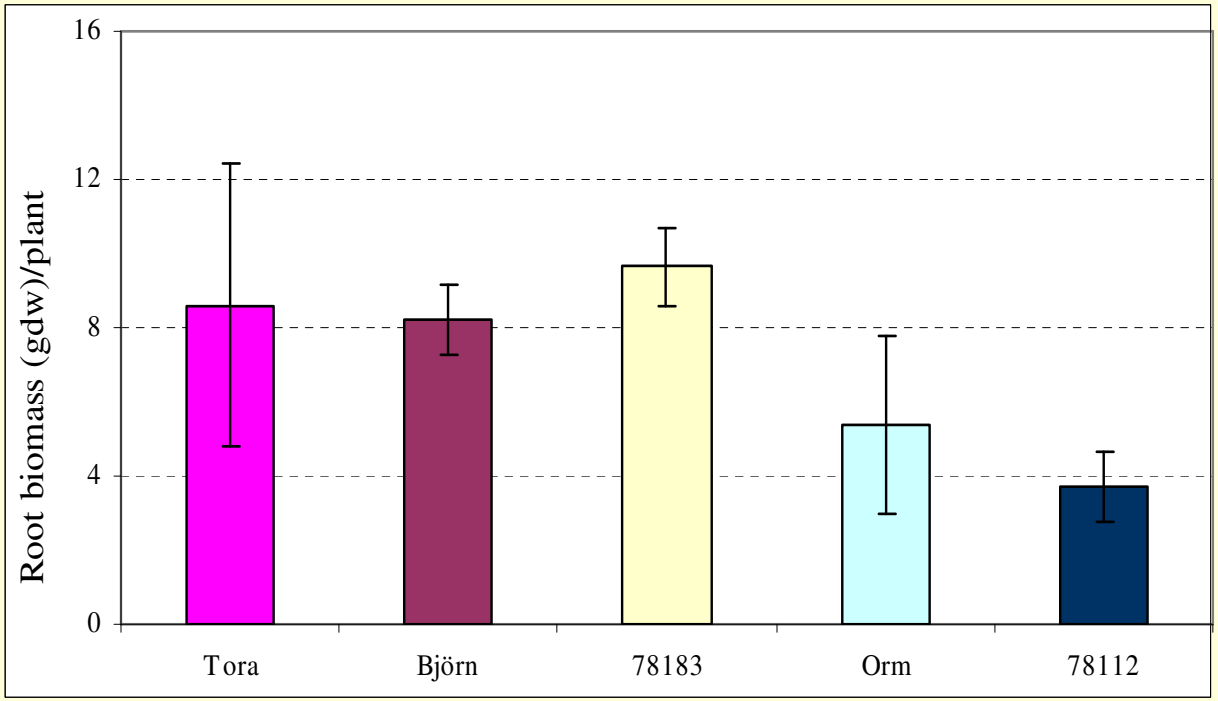
The leaf N levels in creosote soil



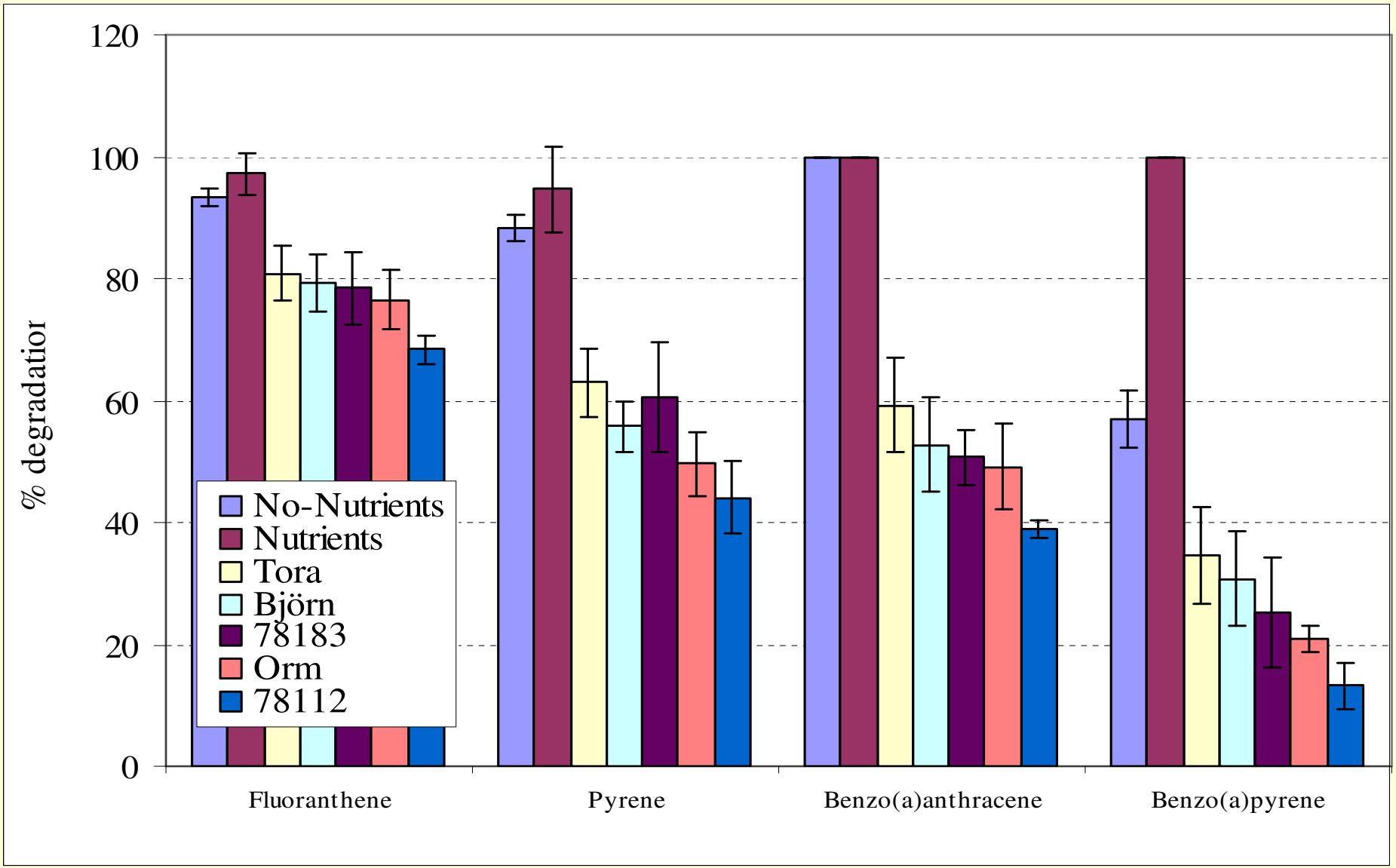


Degradation of certain PAHs with plants in creosote soil

Root biomass in creosote soil



Degradation of certain PAHs with and without plants in creosote soil

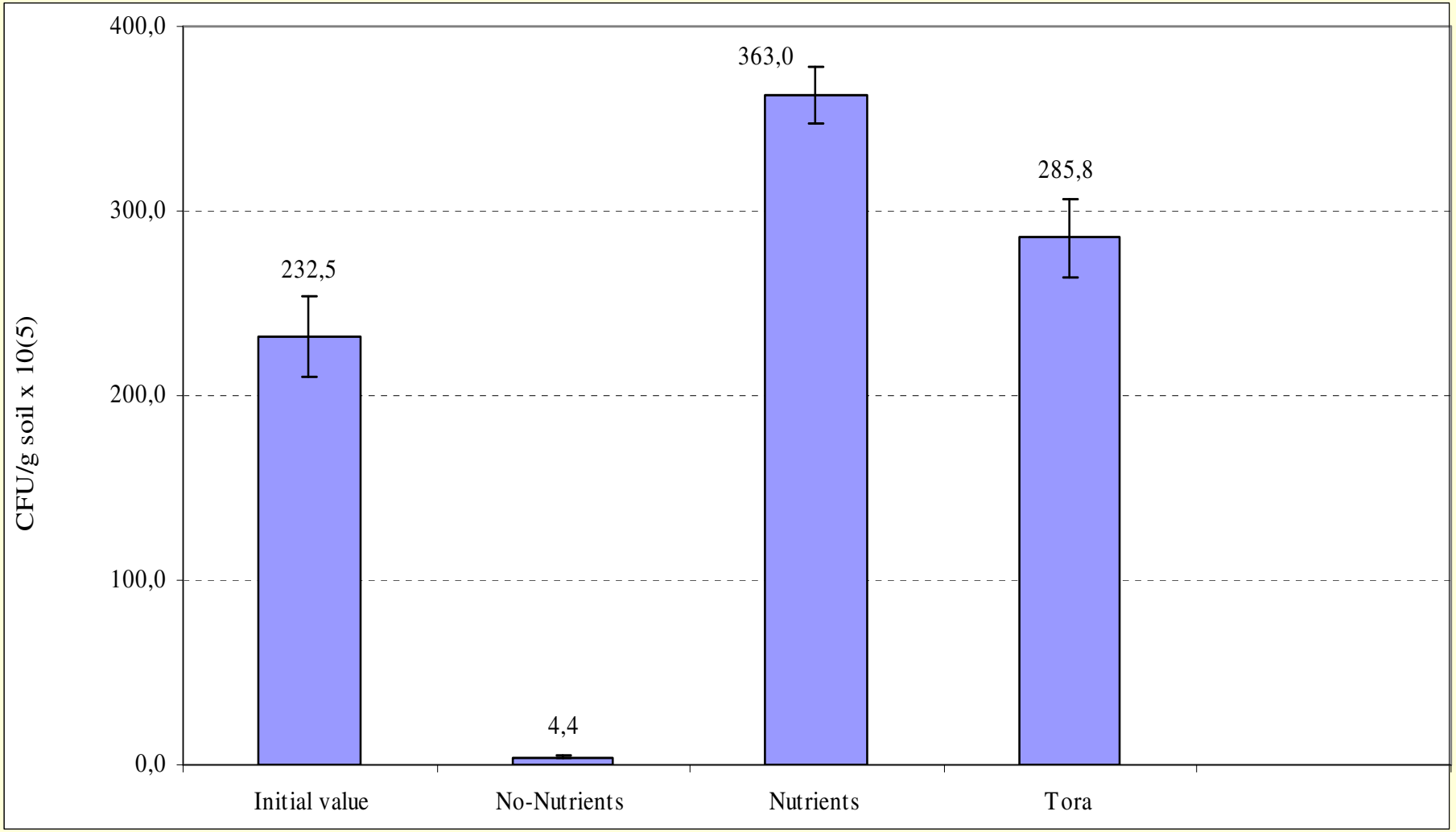


Diesel degradation with and without plants

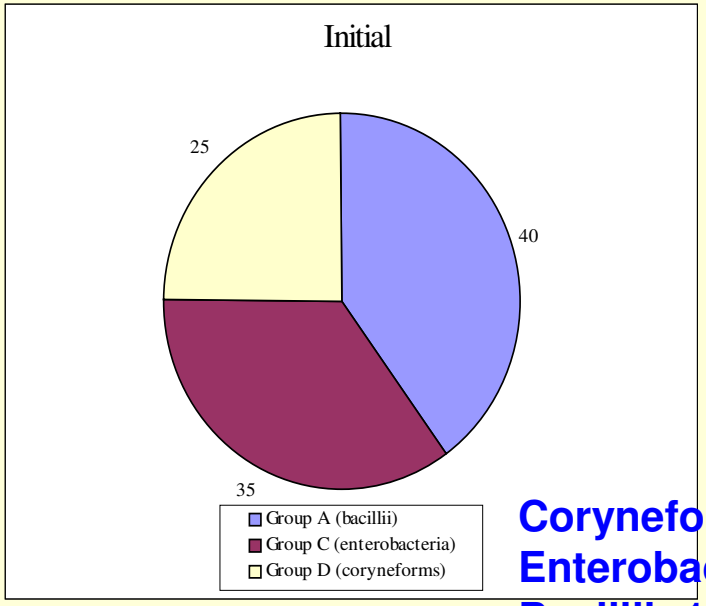
		Initial value (mg/kg)	*% of degradation (after 4 months)*		
			Control (%)	*+ Nutrients (%)*	*+ Tora (%)*
Aliphatics	C5-C16	350	55.7 (8.6)	61.4 (2.9)	54.3 (5.7)
	C16-C35	750	47.3 (1.3)	47.3 (12.0)	42.0 (6.7)
Aromatics	C8-C10	9.1	65.4 (9.9)	59.9 (16.5)	70.3 (6.6)
	C10-C35	38	89.5 (2.1)	90.4 (4.5)	90.4 (3.4)

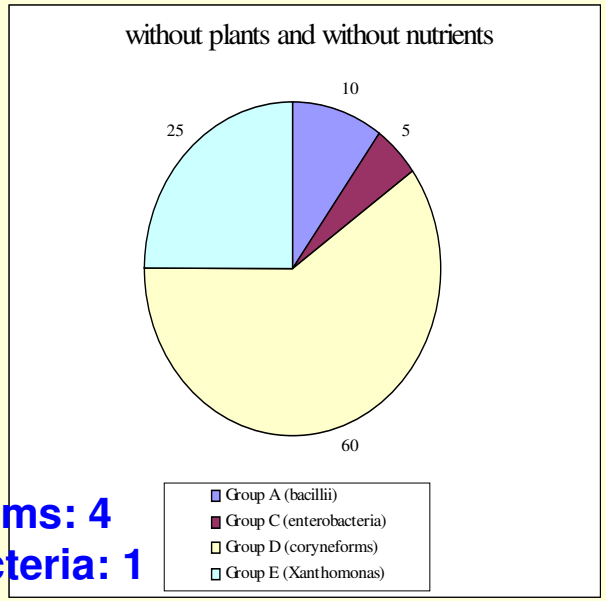
**** The initial total PAHs (C10-C20): 10 mg/kg dry soil***

The bacterial counts in creosote soil

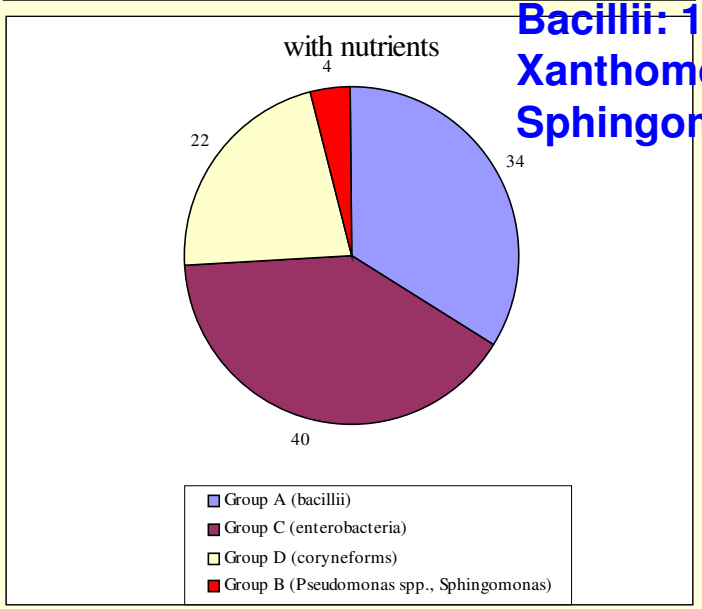


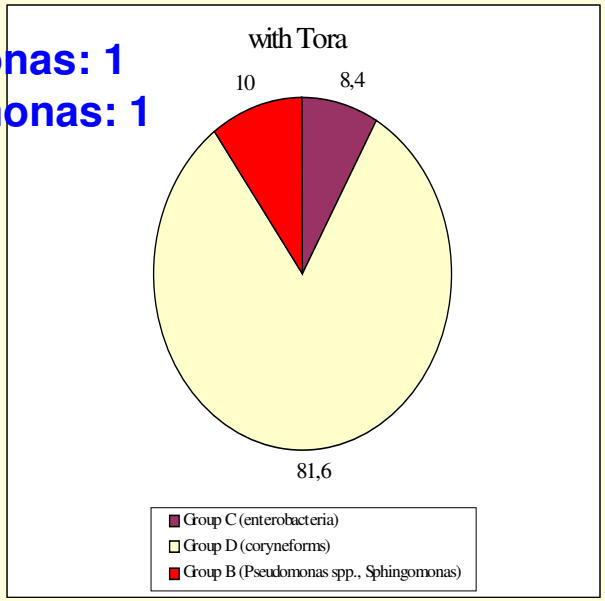
The bacterial groups in creosote soil





Coryneforms: 4
Enterobacteria: 1
Bacillii: 1
Xanthomonas: 1
Sphingomonas: 1





5. Conclusions

- ✓ None of the five willow clones showed better degradation of any PAHs compared to treatments without plants

- ✓ No significant differences were found regarding shoot biomass between the clones. But higher root biomass of 78183, Tora and Björn was found as compared to 78112 clone in the creosote soil.

- ✓ Root biomass increased and the Shoot/Root ratio (S/R) decreased for most clones at the higher concentrations of creosote and diesel contaminants.

- ✓ Overall, there were little differences in degradation of most PAHs between the five Salix clones. Tora, Björn and 78183 were better than 78112 and Orm for certain PAHs in creosote soil

- ✓ The presence of plants in all three soils increased the bacterial counts and stimulated group (*Pseudomonas* spp, *Sphingomonas*) and (coryneforms).

- ✓ Nutrient addition stimulated degradation of certain PAHs and increased the bacterial counts particularly group (*Pseudomonas* spp, *Sphingomonas*) and (enterobacteria).

Acknowledgement

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Thanks for your attention!