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Water & Nutrient Stress Increase Root Exudation

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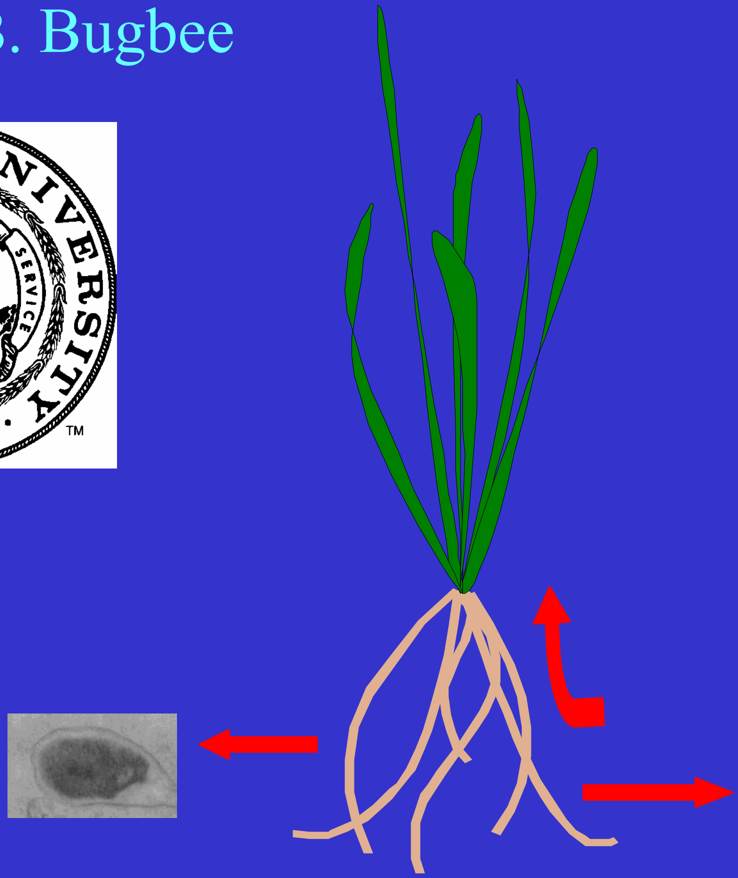


Objectives

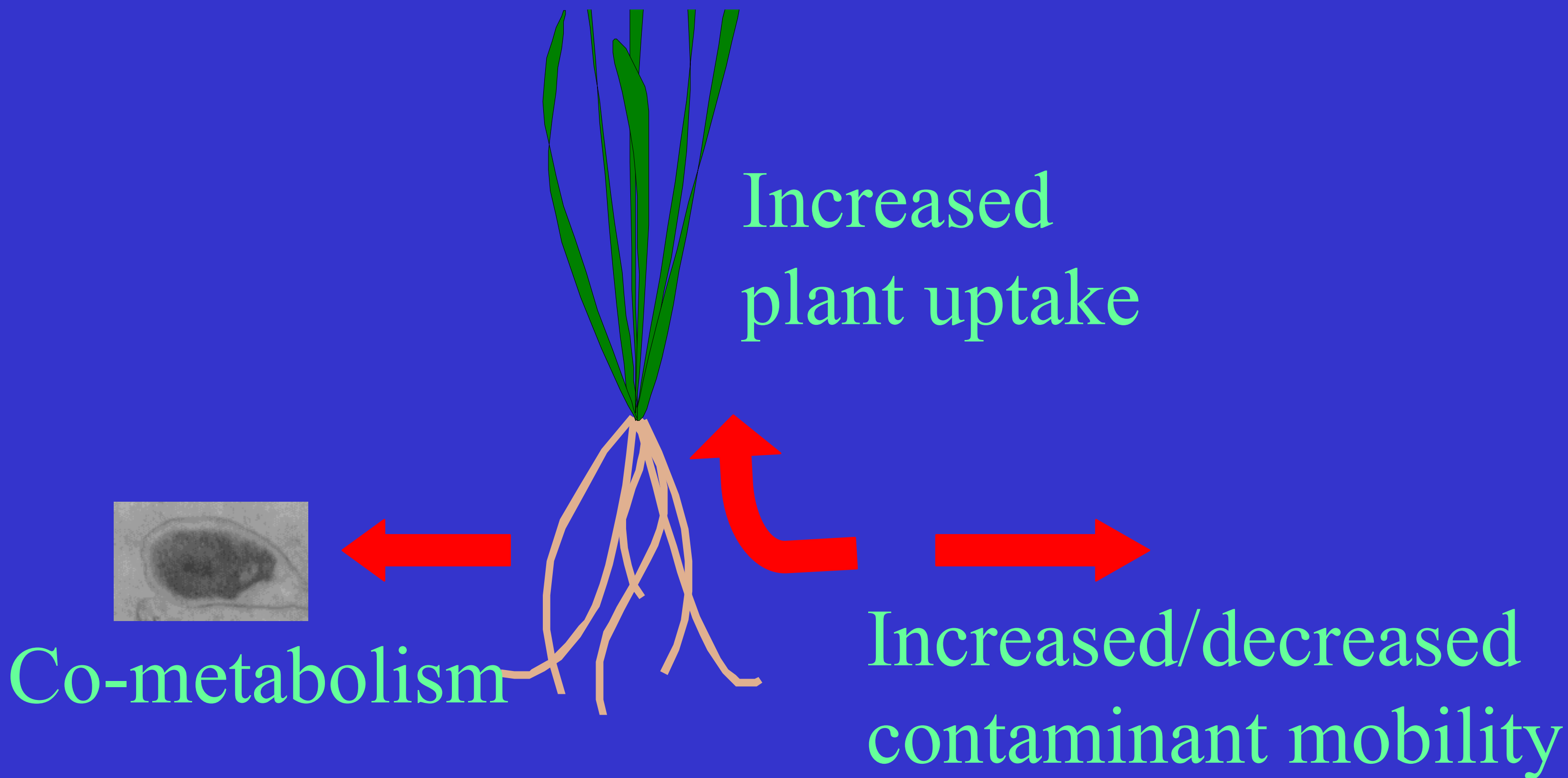
Develop procedures to:

- Grow *healthy* plants under sterile conditions
- Manipulate root exudation with stress
- Quantify total organic carbon in exudates
- Determine composition of exudates using GC-MS

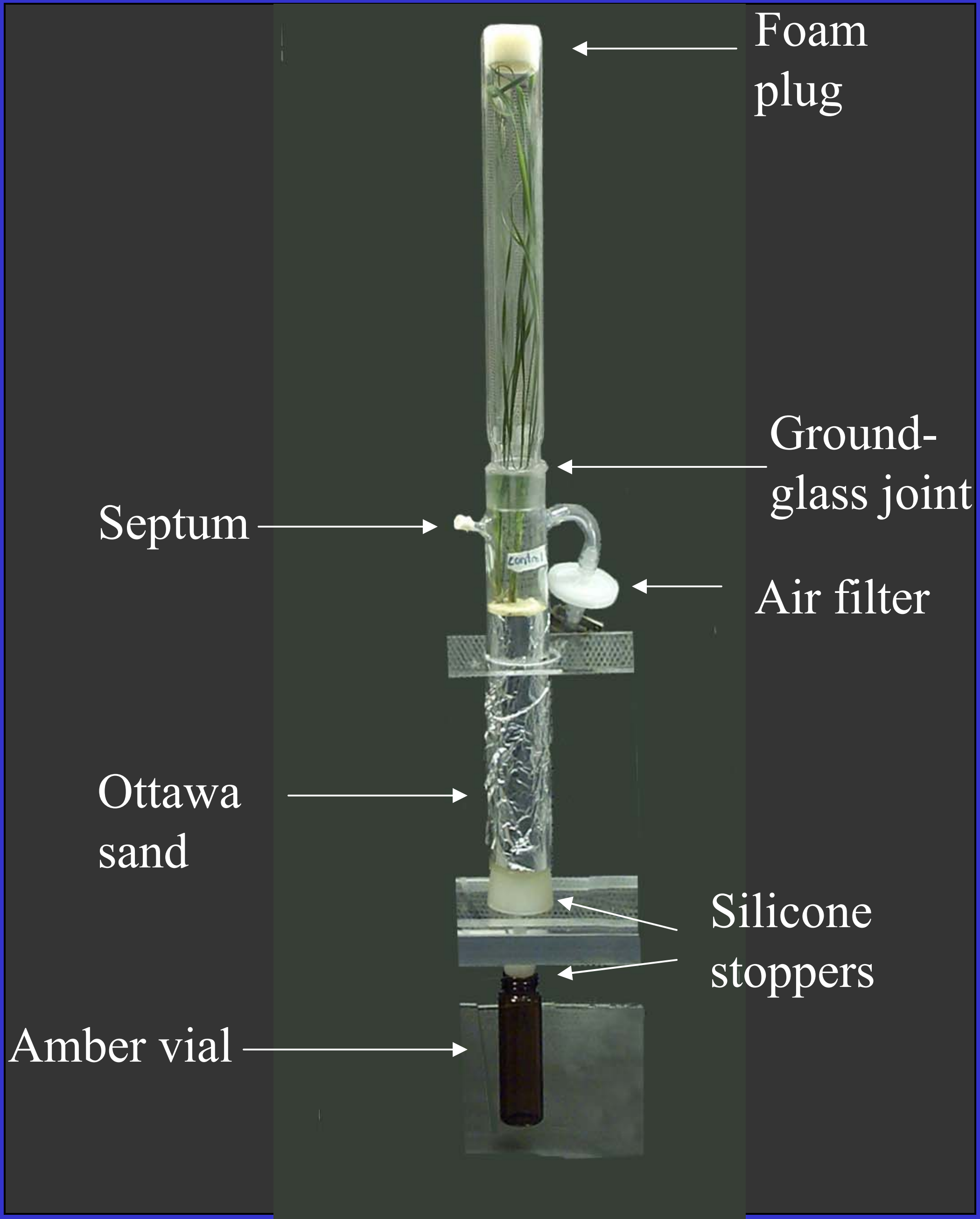
Implications for Phytoremediation

Our focus for the qualitative analysis: organic acids

The chelating properties of these compounds can be useful for phytoremediation, and they are a class of compound most likely to be found in root exudate



System for sterile culture

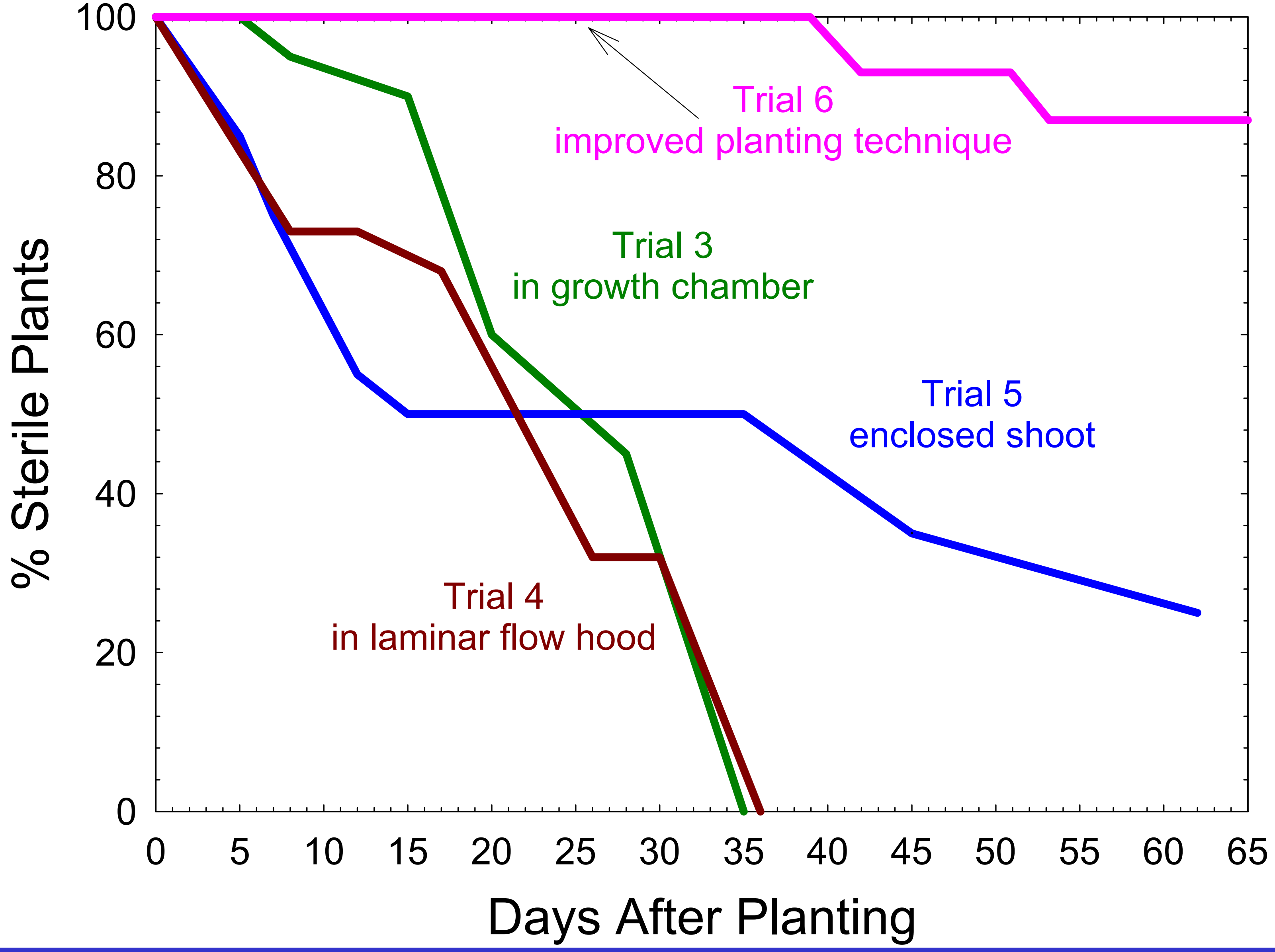


HPS lamps

Laminar flow hood

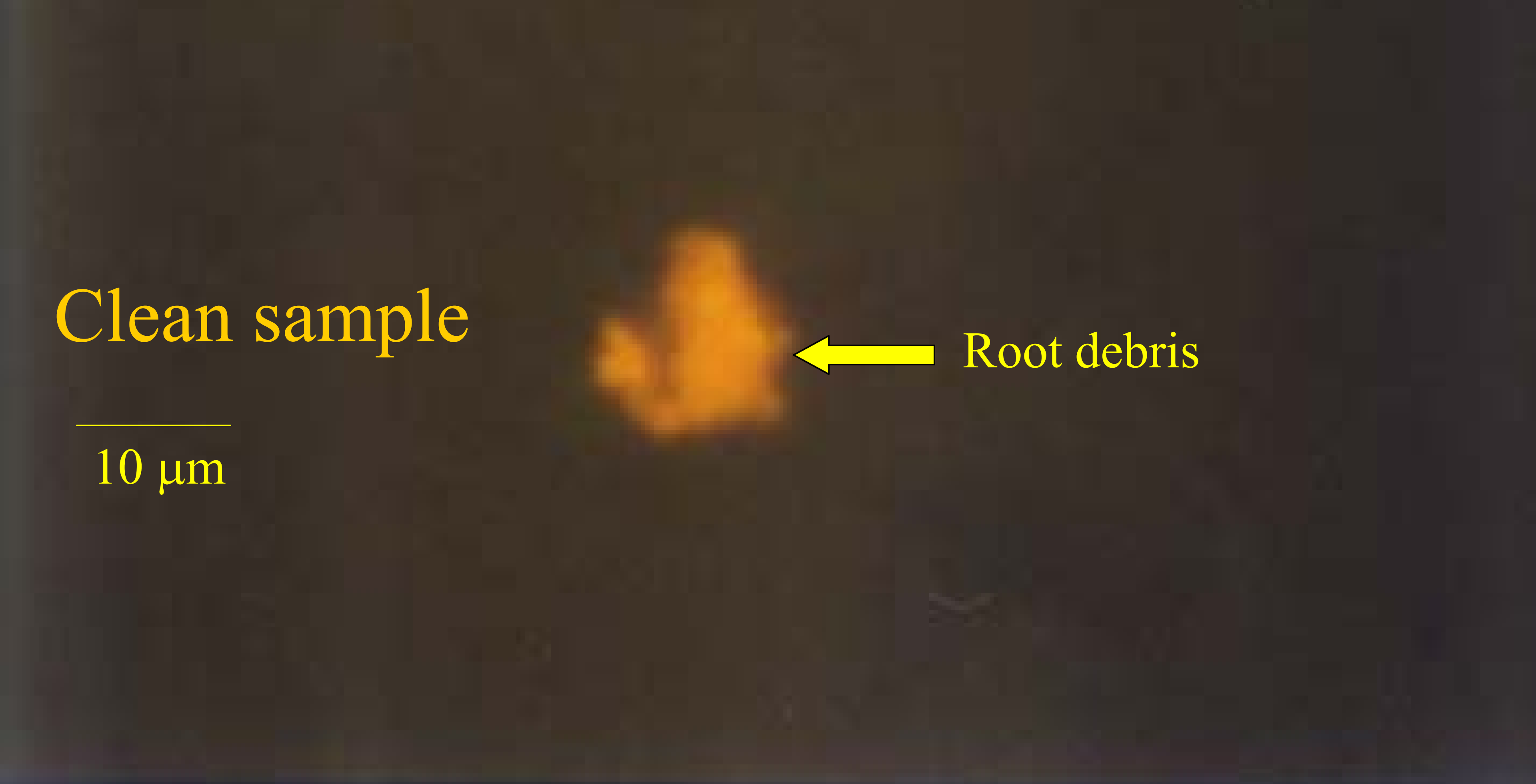
Treatments

- High NH_4^+
- K^+ stress
- Drought
- Flooding


% Sterile Plants
100
80
60
40
20
0
0
5
10
15
20
25
30
35
40
45
50
55
60
65
Days After Planting
Trial 6
improved planting technique
Trial 3
in growth chamber
Trial 5
enclosed shoot
Trial 4
in laminar flow hood

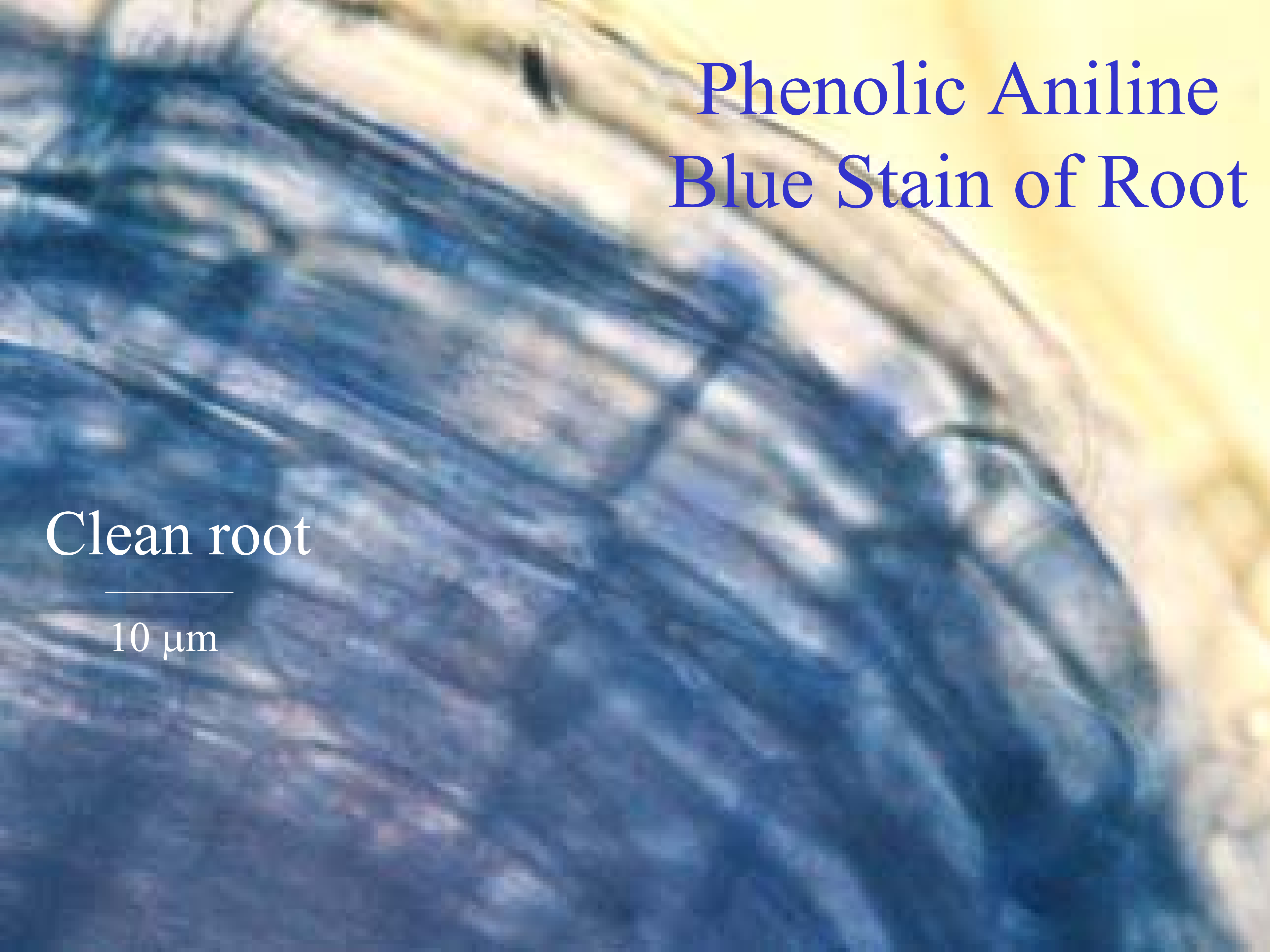
Assessing microbial contamination

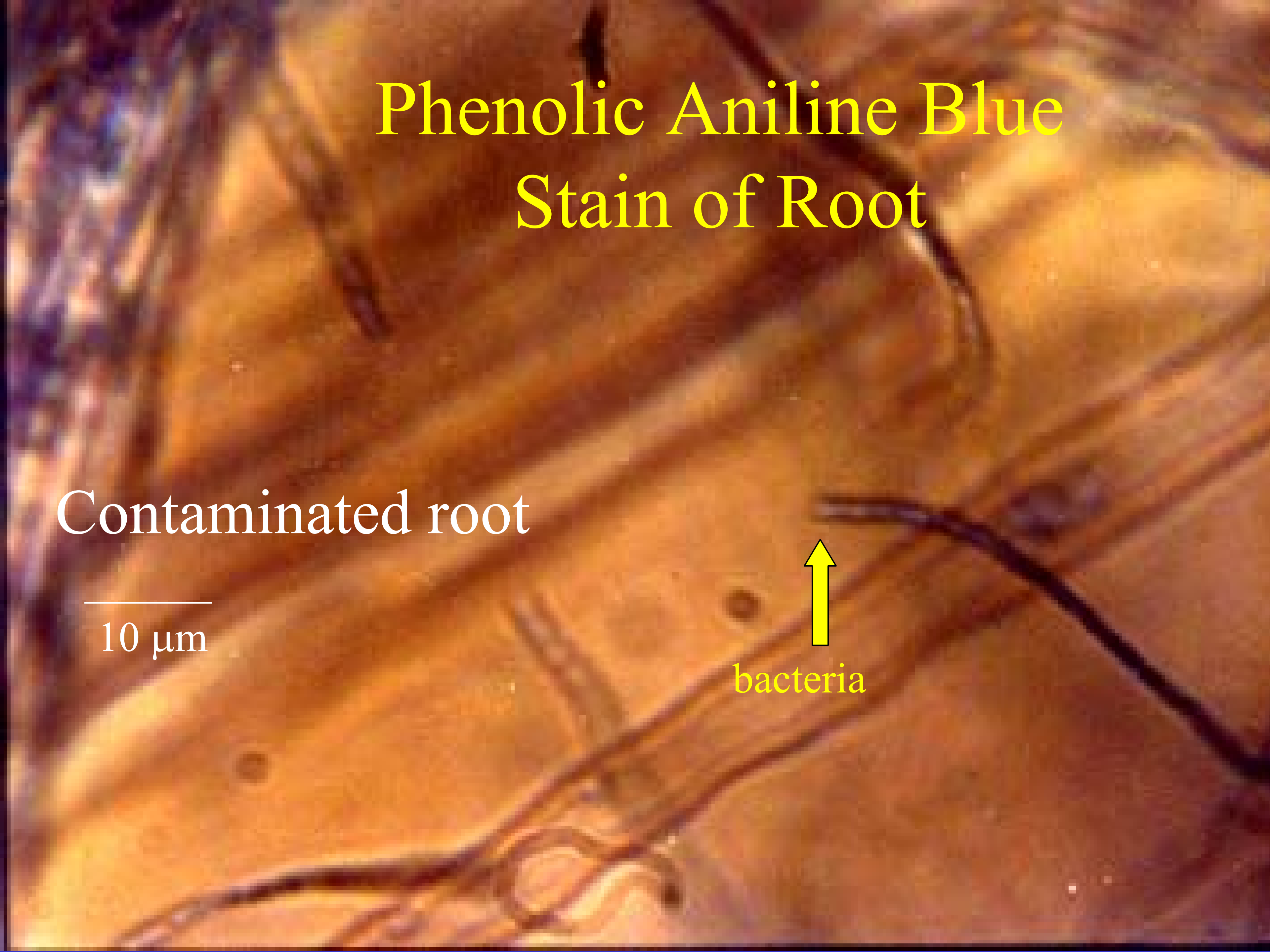
Verifying Plate Counts: Acridine Orange Stain of Leachate



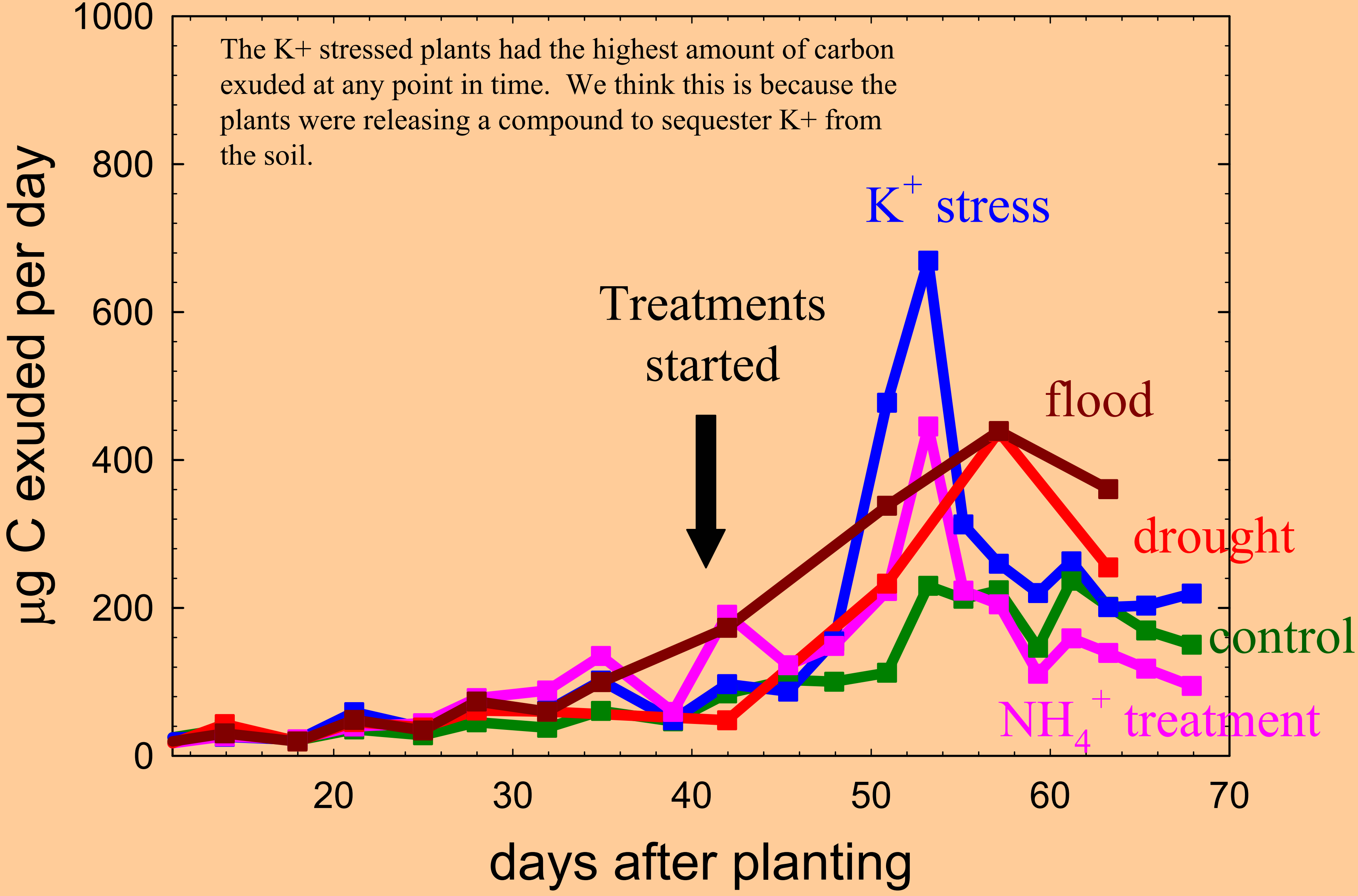
Verifying Plate Counts: Acridine Orange Stain of Leachate

Phenolic Aniline Blue Stain of Root




Phenolic Aniline Blue
Stain of Root
Contaminated root
10 μm
bacteria

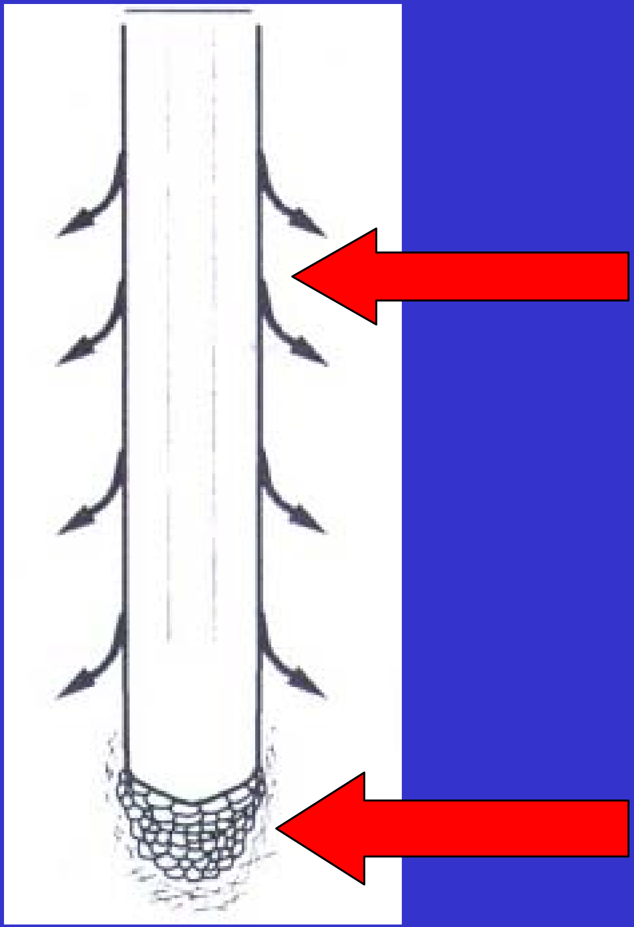
Treatment Averages



Cumulative carbon exuded per gram dry plant

	mg C exuded per g dry plant		Percent of control
	Average	Std. dev.	
control	2.6	0.4	
NH4+	2.3	0.1	90
K+	3.7	0.6	144
flood	3.8	0.9	145
drought	4.4	0.5	170

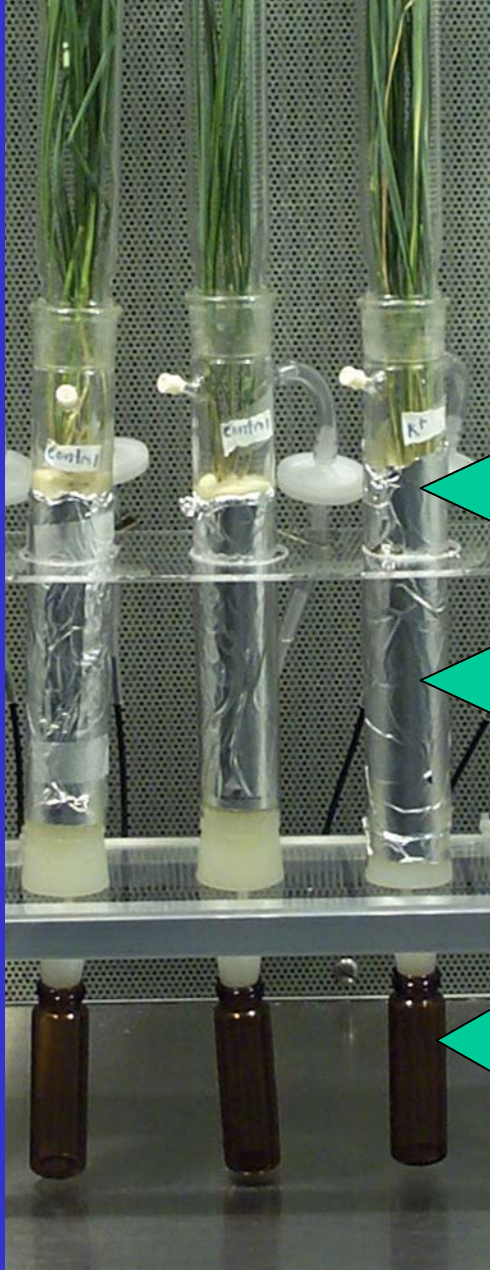
Primary types of exudates



Compounds released by roots

Sloughed-off cells

Distribution of Carbon

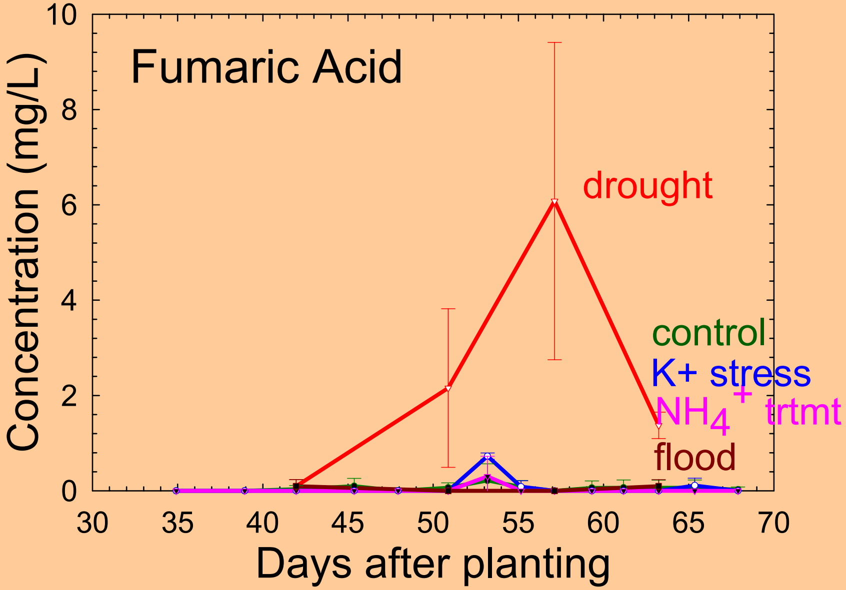


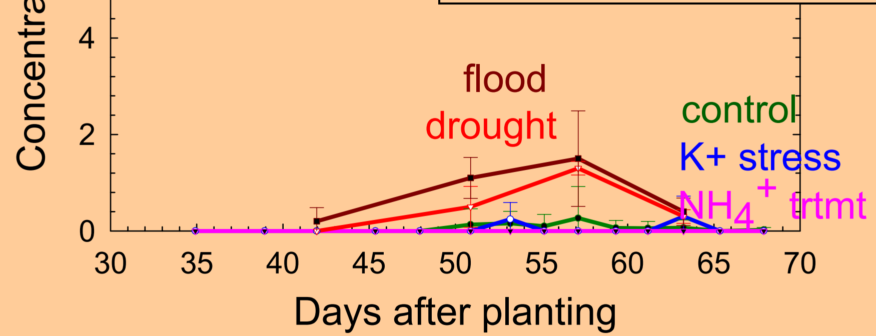
Rhizosphere sand	17 %
Bulk sand	9 %
Leachates	
Soluble	63 %
Insoluble	11 %
	100 %

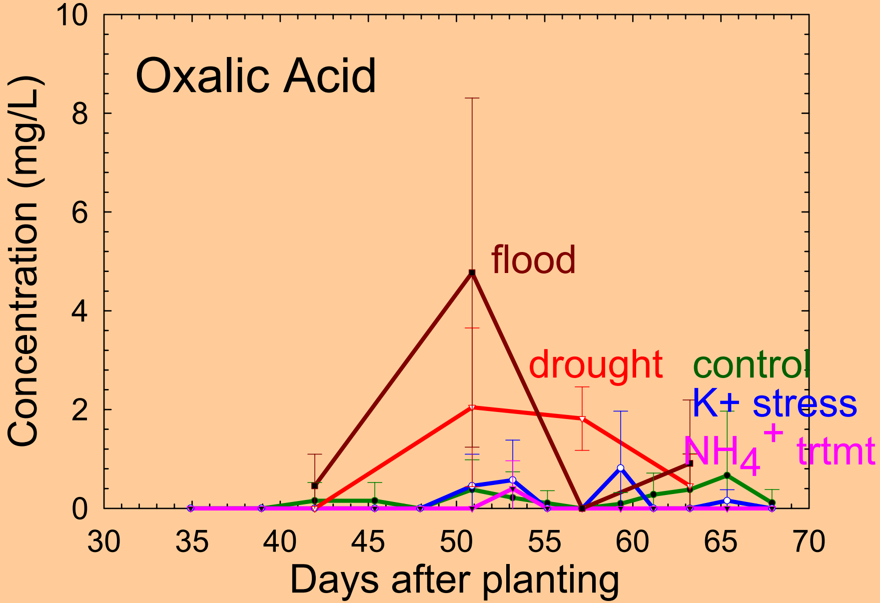
Based on the distribution of carbon released by the roots (mostly soluble with not much left on the sand), we conclude that the exudates we're seeing are mostly compounds released directly from the root, not whole cells released from the root.

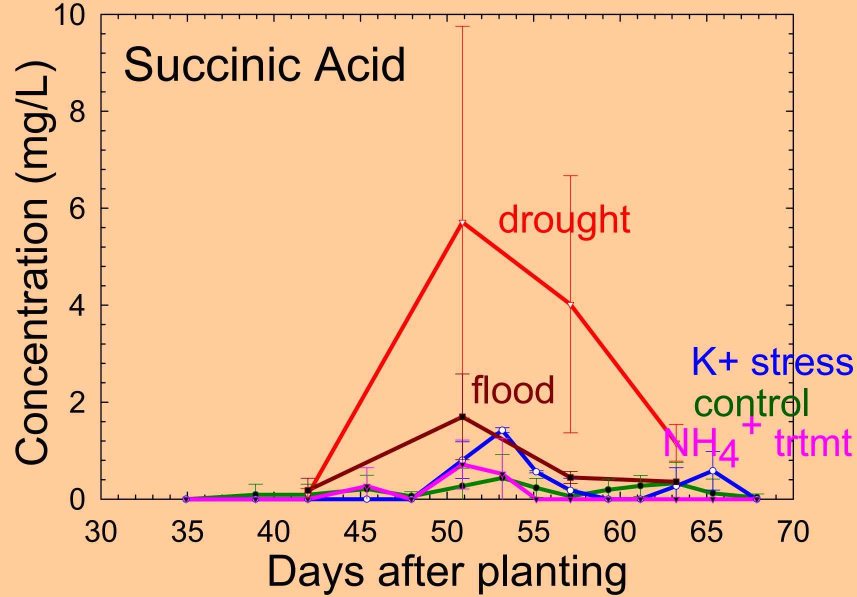
GC-MS Data: Exudates

Unlike the TOC graph, organic acids were exuded in the largest amounts from the drought and flooding treatments. This may be due to buildup of osmotic potential to deal with the low water potentials in the drought treatment, or just leakier root cells due to the stress treatments.

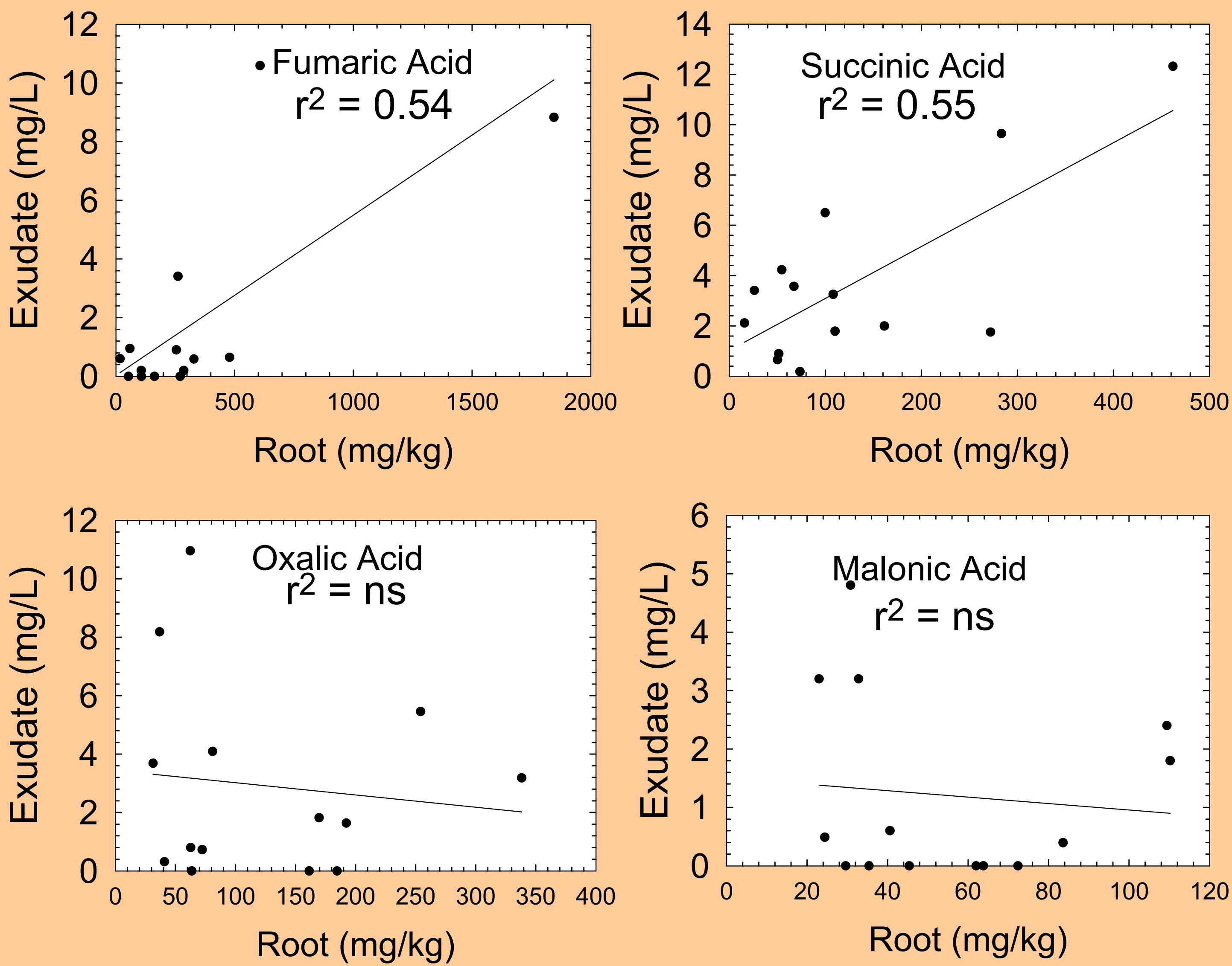








What's in the root vs. what's released by the root



Conclusions

1. Stress increases root exudation. Drought and flooding treatments increased release of organic acids.

2. Concentrations of succinic and fumaric acid in the root correlated with amounts released by the root.