

# Using Plants to Remediate Petroleum-Contaminated Soil - Project Continuation – Quarterly Report

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**Title:** Using Plants to Remediate Petroleum-Contaminated Soil - Project Continuation

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**Institution:** University of Arkansas

**EPA Project Officer:** Bala Krishnan

**Project Period:** July 1, 2001 to June 30, 2002 ( N/C extension till May 15, 2003)

**Project Amount:** \$145,298

**Research Category:** Phytoremediation

This report covers the July 1, 2001 to October 1, 2001 period and summarizes our current IPEC phytoremediation studies that consist of an on-site field project in southern Arkansas and a mathematical modeling project.

## Field Study

The field site in El Dorado, AR is located in a bermed crude oil storage/separation facility that was the site of an intentional spill in 1997 by vandals. The experimental plots consist of four replicates of the following treatments: (1) nonvegetated-nonfertilized control, (2) ryegrass (*Lolium multiflorum L.*) - fescue (*Festuca arundinacea Schreb.*) + fertilizer, and (3) bermudagrass (*Cynodon dactylon (L.) Pers.*) - fescue + fertilizer. Each field plot has 12 microplots (>soil socks=) that contain homogenized soil that allow monitoring of the field treatments, on a smaller scale, with less effect of field variability of the contaminant levels.

Total Petroleum Hydrocarbon (TPH) levels analyzed at T=6 months showed that contaminant reductions were significantly greater in the bermudagrass - fescue + fertilizer treatment than the nonvegetated, nonfertilized control (Fig. 1). The T=17 month TPH sample analyses are complete and data are currently being evaluated.

On 28 September 2001, 22 months after establishment of vegetation at the site, soil and plant samples were collected from the plots. All plant species exhibited substantial plant growth. Root growth characteristic analyses have been conducted and data are being analyzed.

Total bacterial (Fig. 2) and Polycyclic Aromatic Hydrocarbon (PAH) degrader (Fig. 3) levels for T=22 months were higher in the fertilized-vegetated plots as compared to the nonfertilized, nonvegetated control similar to T=6 and 17 month analyses. The increase in microbial levels is an indication of increased microbial activity, which could lead to further contaminant level reductions.

## Mathematical Model

We are working on modifications to the fractal root models so that the morphology of the 'virtual' roots matches data collected from measurements with the WinRhizo® system for grass root samples

collected at the El Dorado site. We have consulted with a statistician regarding the appropriate data sets to be generated so that a reasonable functional relationship between the root biomass (expressed as a volume percentage) and the rhizosphere volume. Sensitivity studies of the effect of seasonal root growth patterns on the dissipation of diesel fuel were performed, and the results presented at the IPEC conference in November. The analysis suggests that the particular growth pattern is less influential than the average annual standing biomass with respect to contaminant dissipation.

### **Technology Transfer**

Abstracts and titles of poster or oral presentations given during this quarter include:

W.D. Kirkpatrick, White, P.M., G.J. Thoma, D.C. Wolf, C.M. Reynolds, and E.E. Gbur. 2001. Plant response to N addition in petroleum-contaminated soil. *In* 2001 Agronomy abstracts. ASA, Madison, WI.

White, P.M., W.D. Kirkpatrick, G.J. Thoma, D.C. Wolf, C.M. Reynolds, and E.E. Gbur. 2001. Field study to evaluate phytoremediation of petroleum-contaminated soil. *In* 2001 Agronomy abstracts. ASA, Madison, WI.

White, Jr., P.M., W.D. Kirkpatrick, D.C. Wolf, G.J. Thoma, R.M. Reynolds. 2001. Phytoremediation of crude oil-contaminated soil. *In* 8<sup>th</sup> Annual International Petroleum Environmental Conference 6-9 November 2001. Houston, TX.

Thoma, G.J., T.B. Lam, S. Ziegler, D.C. Wolf, R.M. Reynolds. 2001. A Mathematical Model of Phytoremediation of Crude Oil Contaminated Soils. *In* 8th Annual International Petroleum Environmental Conference 6-9 November 2001. Houston, TX.

Abstracts and titles that have been submitted for presentation as posters or presentations in the future include:

White, Jr., P.M., G.J. Thoma, D.C. Wolf, and E.E. Gbur. 2002. Field evaluation of crude oil-contaminated soil phytoremediation. *In* 2002 Southern Branch Agronomy abstracts. ASA, Madison, WI.

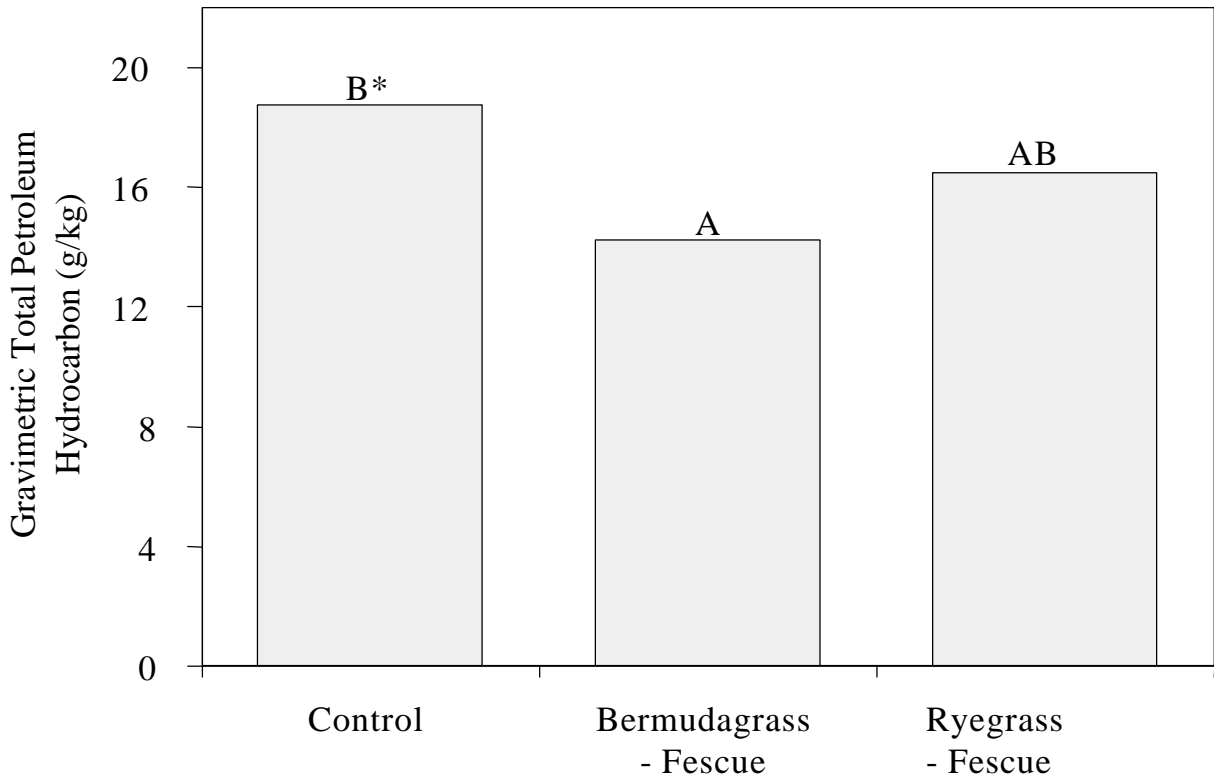


Figure 1. Total petroleum hydrocarbon levels in vegetated fertilized or non-vegetated non-fertilized plots at T=6 months. \*Bars with the same letter are not significantly different at the 10% level.

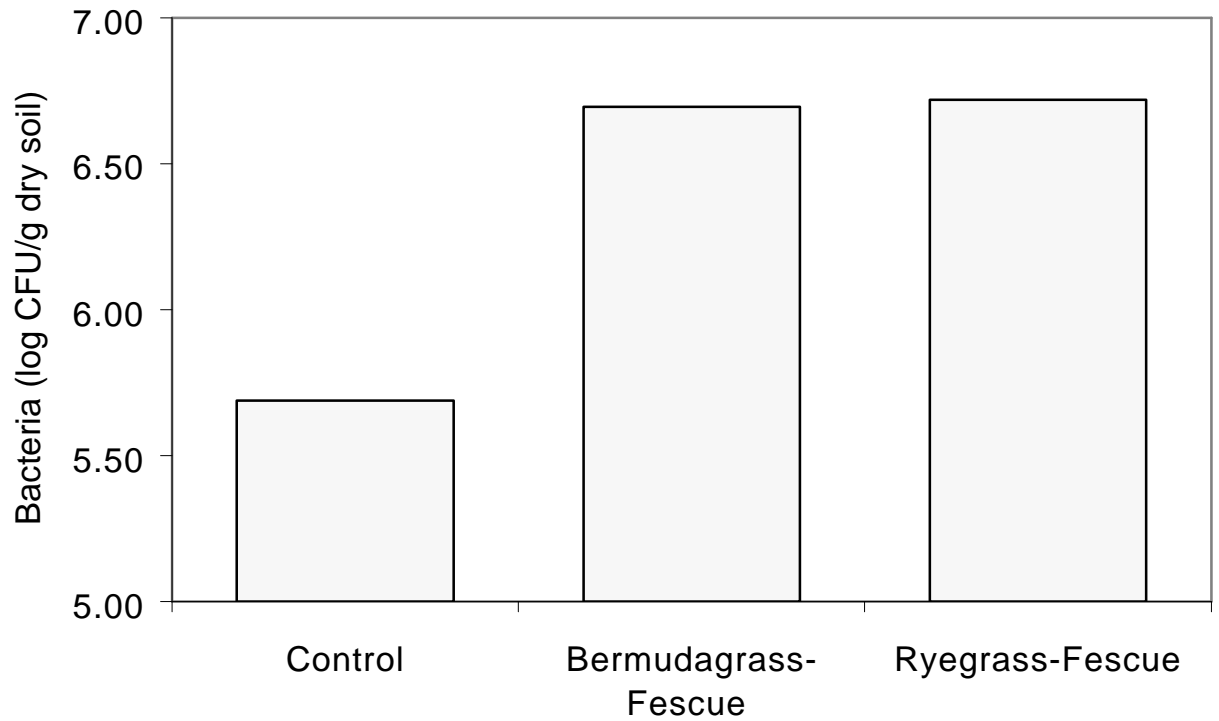


Figure 2. Total bacterial populations isolated from control, bermudagrass, and fescue plots T=22 months at the El Dorado, AR, field site.

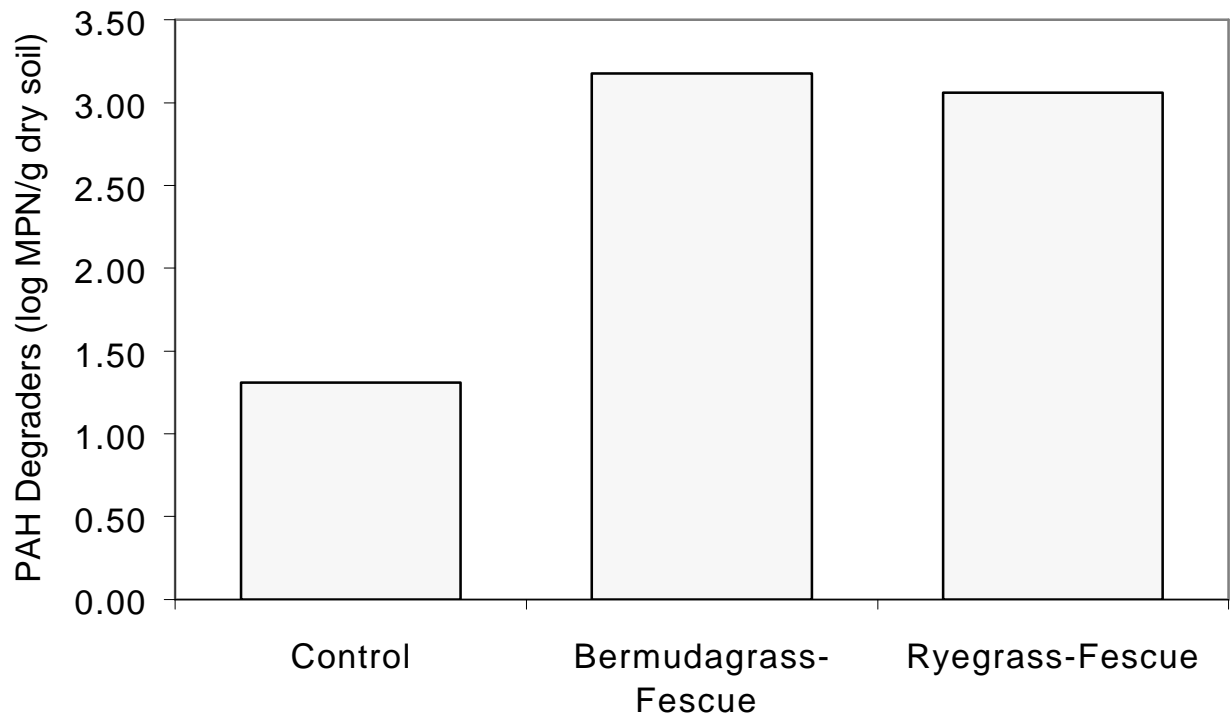


Figure 3. Polycyclic Aromatic Hydrocarbon (PAH) degrader populations isolated from control, bermudagrass, and fescue plots T=22 months at the El Dorado, AR, field site.

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