Native Prairie Plants in Phytoremediation: Successes, Limitations and Knowledge Gaps

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Phytoremediation, the use of plants to remove, degrade or stabilize sites contaminated with organic or toxic chemicals is gaining in popularity as an alternative and economical technique in environmental remediation. Interactions between plants and microorganisms are the primary mechanism for petrochemical degradation in phytoremediation. Phytoremedial planning must take these interactions into account so that remedial efforts are successful and economical.

As the chemical profile of a site changes, the plants growing on the site may also change. Plants growing presently on a 20 year old contaminated site may not be ideal for reclamation of a site contaminated 5 years ago. It is proposed that sites be identified and graded according to the chemical profile of the contaminants, age of contamination, and native plants growing on the different sites. This will ensure that in the future an ideal native plant seed mixes can be planted according to the nature and age of the site.

Hydrocarbon degrading microorganisms from a contaminated site will be isolated, grown in the laboratory and re-introduced to the same contaminated site for remediation. This approach utilizes indigenous microbial communities thereby increasing the likelihood of success since microbes from another site may not be as adapted to the site being remediated.

Several genera of microorganisms in the root zone or rhizosphere of plants are able to trigger plant growth promotion (PGP). If plants inoculated with PGP can thrive this will lead to increased plant biomass, enhanced microbial communities in the rhizosphere thereby increasing contaminant mineralization. It is proposed that PGP organisms be isolated from plants of contaminated sites, screened in the laboratory and then introduced in a reclamation experiment with native prairie plants.

Scope of The Research

To date, research efforts by Alberta Research Council (ARC) have identified and successfully used different native plant species that are capable of growing on contaminated soils in a number of projects. An example of some native species that have the ability to effectively remove polycyclic aromatic hydrocarbons from contaminated soil included Blue grama, Canada wildrye, Indian rice grass, little blue stem and side oats grama. The ARC is presently developing varieties of some of these species.

We aimed to research and answer the following novel questions:

1) Will hydrocarbon degrading microorganisms (bacteria/fungi) isolated from a contaminated site, grown in the laboratory and reintroduced into the same site result in faster and more complete degradation of petroleum hydrocarbons against where no microorganisms were introduced? This is of considerable benefit to the industry because indigenous bacteria will be introduced rather than those from another site, resulting in higher colonization rates as well as faster reclamation of land.

2) From the time a site becomes contaminated, is there a progression of plant colonization as the chemical and physical profile of the site changes? Additionally, are the types of plants that grow on contaminated sites, influenced by the chemical profile of the site? While native plants that are able to grow on petroleum laden sites have been utilized for land reclamation in numerous studies, there has been no previous work in the world that has examined successional patterns of plant colonization or correlated hydrocarbon profile of the soil with the profile of the plants on hydrocarbon contaminated sites. This will benefit industry because the work will not be haphazard but will introduce native plants based on the age and chemical profile of the site to be reclaimed thereby resulting in more complete and faster land rehabilitation.

3) The roots of most plants that exist in the world are intimately colonized with bacteria and fungi and some of these microorganisms help plants to grow (plant growth promoting (PGP) rhizobacteria or fungi) by providing moisture (fungi), essential amino acids or other nutrients (bacteria), protection from pathogenic microorganisms or by decreasing the toxicity of chemicals in the soil thereby allowing the plants to thrive. Scientists have used PGP organisms in crops so as to minimize expenditures in fertilizer input, drought resistance and to protect plants from pathogens. However, PGP organisms have not been used anywhere in the world, in the field, to promote plant growth in phytoremediation efforts. Will the sowing of PGP bacteria\fungi, isolated from native plants growing on petroleum hydrocarbon spilled sites, help to ensure better growth of native plants on the reclamation sight with minimum application of fertilizer or watering? Benefits to industry and reclamation efforts are that plants growth would be robust, require minimum inputs of nutrients and moisture thus resulting in considerable savings and efficient and quick reclamation of land.

Therefore to achieve optimum and rapid result in phytoremediation efforts, an appropriate plant-microbe community is essential for success. This requires native plants tolerant of hydrocarbon contamination along with varied root characteristics so as to maximize root exposure within the soil and thereby ensure robust microbe-root-contaminant contact leading to fuller degradation. It is also essential to have microorganisms that can degrade hydrocarbons and promote plant growth.
The Native Plant Group at the ARC proposes to collaborate with industries in the following:

1. Identify and grade sites according to the chemical profile of the contaminants, age of contamination, and native plants growing on these sites. This will ensure that in the future an ideal native plant mixture can be planted according to the profile of contamination and age of the site.
2. Multiplication of the plant species identified in the above table.
3. Devise an optimum combination of plants and microorganism that are able to mineralize hydrocarbons and promote the growth of plants leading to efficient and rapid remediation of contaminated areas.

This approach would provide the industry with performance tested plant species and allow them to meet their regulatory requirements in a cost effective manner. Interested industries are asked to contact Jay Woosaree (Telephone 780-632-8209 or email: jay@arc.ab.ca).