BRIDGING THE GAP BETWEEN PHYTOREMEDIATION, AGRONOMY, HORTICULTURE, AND FORESTRY

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Zalesny, R.S. Jr., and Bauer, E.O. 2007. Selecting and utilizing *Populus* and *Salix* for landfill covers: implications for leachate irrigation. International Journal of Phytoremediation 9(6): 497-511. https://doi.org/10.1080/15226510701709689.

Rationale

A growing number of closed municipal landfills throughout North America has prompted the need for treatment strategies to clean up landfill contamination. Phytoremediation, the use of plants to clean up contaminated water and soil, is an environmental alternative to traditional remediation methods. *Populus* (poplar) and *Salix* (willow) tree species that demonstrate fast growth [1], elevated water usage [2,3], and extensive root systems [4] have been identified as effective phytoremediators in helping to clean up contaminated landfill sites. Interest in improving the effectiveness of poplar and willow species for phytotechnologies has created a need for an improved selection method of clones. **Phyto-recurrent selection** presents a system of evaluation and selection cycles whereby superior hybrid poplar and willow clones are selected based on desired traits.

> "Attention to project development, clone selection, tree establishment and evaluation of success metrics will help bridge the gap between [tree improvement methods used in agronomy, horticulture, forestry, and pre-existing environmental clean-up strategies]"
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> *- Zalesny and Bauer (2007)*

Objectives

- Outline the method of phyto-recurrent selection to improve phytoremediation potential and survival of hybrid poplar and willow for field deployment
- Identify tree establishment and maintenance strategies that maximize the effectiveness of short rotation woody crops as phytoremediators in the field
- Establish metrics used for evaluating the success of poplar and willow trees

Project Development

Before beginning a phytoremediation project it is important to first identify the objectives of the project and the biological processes that will be used to accomplish them. By knowing the objectives and the biological processes involved, a set of desirable traits can be chosen and easily measured to determine phytoremediation success throughout the course of the project.

Key Points

- Phyto-recurrent selection improves phytoremediation potential
- Plant- and non-plant-traits can be used to evaluate phytoremediation success
- Phytoremediation should implement agronomy, horticulture, and forestry principles

Clone Selection

Phyto-recurrent selection is a critical first step in identifying and selecting clones that exhibit favorable genotypes based on traits of interest. Selected test clones are grown in a greenhouse setting and then evaluated based on measurable traits. Clones that demonstrate high phytoremediation potential and superior genetic variation in the given environmental conditions are selected and evaluated further for field establishment.

Tree Establishment in the Field

Once favorable clones are selected from the greenhouse, tree establishment in the field must consider site requirements, preparation, and maintenance. In addition, cutting selection (unrooted cuttings vs. rooted stock or cuttings), cutting collection time (December-mid March), and preparation of cuttings (pre-establishment soaking of cuttings) improve survival and phytoremediation success.

Phyto-recurrent selection testing.
Photo by Ron Zalesny

Tree Establishment in the Field (continued)

Proper field site preparation is essential for successful establishment of poplars and willows. A combination of mechanical (plowing and tilling) and/or chemical (glyphosate and/or 2-4D) treatment prior to planting provides deep, aerated soil for greater root development, and removes potential competing vegetation, respectively. Additionally, surrounding the planting with fencing provides a pest prevention strategy for sites with a high risk of damage and mortality from larger animals such as deer.

Planting of poplar and willow clones in the field involves a number of strategies, including tree spacing, time of planting and planting devices used. Tree spacing is dependent upon site objectives, although 2.4 m between rows is recommended to allow vegetation control using tilling or disking. Planting when soils are moist and temperatures are warm is ideal. Further, dibble bars and power augers efficiently create holes to plant cuttings in.

After establishing plantings, site maintenance and monitoring are important in maintaining tree health by reducing damage or mortality. Tilling between and within rows using a tractor uproots competing vegetation, although chemical treatment may also be needed. If dry soil conditions are observed during the project, it may be necessary to install irrigation systems. Weather stations, rain gauges, tensiometers (soil moisture tool) and visual surveys can help to monitor environmental conditions and ensure greater plant health.

Implications for the Future

- Clonal material with a broader range of genetic variability should be tested when determining clones to be used in phytoremediation
- Large-scale applications across a range of environmental conditions and contaminants need to be tested

Sources

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Evaluating Metrics of Success

Metrics using both plant- and non-plant-related variables can be employed to evaluate success of the plantings. Allometric traits (e.g., height, diameter) are easily measureable parameters for tree health, while physiological traits (e.g., stomatal conductance) and contaminant levels in plant tissue track biological and phytoremediation processes. Non-plant variables such as soil composition and contaminant levels also provide information about success of the system.

Physiological measurements during phyto-recurrent selection.
Photo by Ron Zalesny

Conclusions

Large genetic variability of clonal poplar and willow trees has allowed researchers to broaden the capabilities of poplars and willows used for phytoremediation. The introduction of phyto-recurrent selection provides a means to further improve phytoremediation potential of short rotation woody crops and select clones based on desired traits and objectives. In addition, proper field establishment and maintenance of trees, along with evaluation of tree metrics, help to quantify tree success.

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