SELECTING POPLAR TREES TO REMEDIATE LANDFILL LEACHATE

Edited by Molly Wagler and Elizabeth Rogers

Zalesny, J.A., Zalesny, R.S. Jr., Wiese, A.H., and Hall, R.B. 2007. Choosing tree genotypes for phytoremediation of landfill leachate using phyto-recurrent selection. International Journal of Phytoremediation. 9:513-530. https://doi.org/10.1080/15226510701709754.

Rationale

Landfills produce leachate when precipitation percolates through. While contaminant levels in leachate generally lessen over time, treatment of the leachate is necessary to prevent ground- and surface-water contamination [1,2]. Rather than employ costly traditional treatment measures, an economically viable alternative is to use leachate as fertilization and irrigation for trees, such as *Populus* species (poplars). Hybrid poplars are commonly used to clean up landfill leachate, and other contaminated soils and water, through the process of phytoremediation. High biomass production, extensive root systems, ability to grow from cuttings, and transpiration capabilities all make poplars an ideal candidate [3]. Superior poplar clones are matched to phytoremediation systems based on site characteristics (e.g., soil type, leachate composition) through phyto-recurrent selection [4]. In this process, multiple testing cycles are conducted, with each additional cycle bringing an increase in cycle length and data complexity.

Objectives

- Evaluate the growth of different poplar genotypes when irrigated with landfill leachate, while at the same time:
    - Develop a phyto-recurrent selection model for future phytoremediation field applications.

Methods

Researchers used the following materials and methods for this greenhouse study:

- Landfill leachate was collected from the Oneida County Landfill.
- Phyto-recurrent selection was employed to select superior genotypes. The data became more complex with each additional cycle. The following parameters were adjusted throughout the cycles in concert with this increase in complexity:
    - Pot type and size
    - Planting medium
    - Irrigation regime
    - Time grown

"These results detail the extensive variation in clonal responses to leachate irrigation, along with the need and efficacy of using phyto-recurrent selection to choose superior genotypes."

- Zalesny et al. (2007)

Key Points

- Phyto-recurrent selection can successfully identify favorable genotypes to be used in the field.
- There is potential for on-site treatment of landfill leachate using poplars.

Poplars being tested during phyto-recurrent selection.

Photo by Ron Zalesny

Methods (continued)

- As the cycles continued, the number of clones decreased, and the number of observed traits increased.
  - ⇒ **Cycle 1:**
    - 25 clones were grown for 14 days.
    - Traits of interest were root number, root dry mass, leaf number, leaf area, and combined leaf and stem dry mass.
  - ⇒ **Cycle 2:**
    - 12 clones were selected and grown for 45 days.
    - Traits of interest were root length, root dry mass, height, leaf number, leaf area, stem dry mass, and leaf dry mass.
  - ⇒ **Cycle 3:**
    - 12 clones were selected and grown for 30 days.
    - Traits of interest were height, leaf number, leaf area, root number (in three different sections), root dry mass (in three different sections), stem dry mass, and leaf dry mass.
- Weighted summation indices were calculated to select superior clones for field planting of Cycle 4.

Conclusions

Clones should be tested before they are implemented in field phytoremediation systems for the best remedial outcome. Early elimination of unsuitable clones is important in selecting those best suited to specific site conditions. Through phyto-recurrent selection, favorable poplar genotypes can be selected, leading to successful field applications.

Implications for the Future

- Future phyto-recurrent selection studies should build upon the current study by altering:
  - Number of clones,
  - Pot type/size, and
  - Length of growing time.
- Field testing of rooted stock may be necessary to assess cutting susceptibility to stress and survival.
- Greater evaluation of the effects of landfill leachate on organisms in the rhizosphere is needed.

Sources

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Findings

Cycle 1

The treatment × clone interaction was significant for all traits. All clones responded differently to the treatments for all traits, as well as to the leachate and water irrigation. High levels of salts in leachate, specifically Cl^- in this study, impacted the growth of weaker, less-tolerant clones.

Cycle 2

Clones had similar responses to leachate treatments in this cycle. While differences in leaf number and height were apparent early on, they became negligible as the cycle progressed. In addition, detrimental effects of the leachate seemed to be most prevalent during root initiation. The treatment × clone interaction was not significant for any of the traits.

Cycle 3

Clones responded differently to the treatments for rooting traits, but not aboveground traits. Clone main effects were significant for all traits, while the treatment × clone interaction was significant for root number (in the top layer of the planter) and root dry mass (in the top and middle layers).

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