HYBRID POPLAR AND RUSSIAN OLIVE: HEIGHT GROWTH, SURVIVAL, AND PHYTOREMEDIATION ON SALINE SOILS

Edited by Elizabeth Rogers

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Zalesny, R.S. Jr., Stange, C.M., Birr, B.A. 2019. Survival, height growth, and phytoextraction potential of hybrid poplar and Russian olive (*Elaeagnus Angustifolia* L.) established on soils varying in salinity in North Dakota, USA. Forests. 10(8):672. https://doi.org/10.3390/f10080672.

Rationale

Agroforestry, the deliberate integration of trees and agricultural crops, provides multiple benefits in agricultural areas, such as reduction of wind speed, enhanced soil quality, and lower energy demands for buildings [1]. Soils that are highly saline, however, such as those in the Northern Great Plains, can negatively impact the growth and survival of agroforestry species. Landowners who wish to implement effective agroforestry systems in such locations must choose species with known salt tolerance, such as Russian olive (*Elaeagnus Angustifolia* L.). Unfortunately, Russian olive is highly invasive, so other salt tolerant tree options for agroforestry systems need to be identified.

Hybrid poplars (*Populus* species and their hybrids) are a group that holds promise for application in agroforestry systems on saline soils. Variation in salt tolerance among hybrid poplar genotypes has been reported [2], with select genotypes identified as being able to tolerate high soil salinity levels [3]. Further, hybrid poplars have been classified as sensitive to moderately salt tolerant, with tolerance largely depending on genotype [4].

Salt tolerance of hybrid poplars has yet to be compared with that of Russian olive. Should poplars demonstrate comparable salt tolerance, they may be considered a viable alternative for establishment in agroforestry systems on saline soils.

"These clones have been highly successful for phytotechnologies, and their response in the current study supports the need for phyto-recurrent selection to monitor and choose genotypes … before advancing them to the field."

- Zalesny et al. (2019)

Objective

- Compare the performance of hybrid poplar genotypes to that of Russian olive when both are grown at a field site with naturally saline soils

Key Points

- Hybrid poplars are a viable alternative to Russian olive for establishment on saline soils
- Genotype selection based on site conditions is key to maximizing the effectiveness of a field planting

Methods

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

Plantings

- Eight poplar clones (unrooted) and one Russian olive accession (bare root stock) were planted
- Seven trees of each genotype planted in three salinity treatments
  - Low (0.1 to 3.9 dS m^{-1}), medium (4.0 to 5.9 dS m^{-1}), and high salinity (6.0 to 10.0 dS m^{-1})
- Trees were grown for four years*

Data collected

- Height, survival, phytoextraction potential

Statistical Analyses

- Analysis of variance (ANOVA), analysis of means (ANOM), Fisher's protected least significant difference (LSD)

*Russian olive was only grown for three years due to a landowner maintenance agreement

Findings

Survival

From the first year to the final year of the study, overall mean survival decreased from 97% to 40%, with an annual decrease of around 20%. Survival rates among treatment × genotype interactions generally became less stable over time, with distinct survival patterns becoming apparent after the fourth growing season.

Overall, poplar survival was lower than expected in regard to similar salinity studies. Potential cause for this discrepancy include high soil salinities coupled with extremes in soil moisture availability, and also tree shelter effects.

Height Growth

In the first two years, the treatment × genotype interaction was not significant for height. However, both treatment and genotype main effects were significant in these years. Variability in height among clones increased from year one to year two.

The treatment × genotype interaction was significant for height in years three and four. At the end of the fourth and final growing season, height ranged from 0.61 ± 0.16 to 3.28 ± 0.20 m, with an overall mean of 2.44 ± 0.09 m.

Height Growth (continued)

Russian olive trees had substantially lower height than poplar clones, which can be attributed to morphological differences; Russian olive is naturally shorter, regardless of soil treatment.

Leaf Phytoextraction

The treatment × genotype interaction was only significant for the phytoextraction of Na (p = 0.0044). The treatment main effect was significant for the phytoextraction of every metal except Cd, Na, and Zn. In general, metal uptake was lowest in the low salinity treatment.

The genotype main effect was significant for the phytoextraction of all metals tested except K and Na. Clonal responses were not consistent among the metals, even within genomic groups. However, Russian olive exhibited a few notable trends in metal uptake. Na, Fe, and Cd uptake was significantly greater in Russian olive than all poplar genotypes. Uptake of Ca and Mg, on the other hand, were significantly lower in Russian olive than that of all other genotypes.

Poplar clone 'DN5' (Populus deltoides × P. nigra) growing at the field site with naturally high saline soils.

Photo by Ron Zalesny

Conclusions

Russian olive performed worse than poplar genotypes for both height growth and survival. Levels of phytoextraction varied widely among the metals and were generally inconsistent within genotypes, and even genomic groups. Russian olive exhibited the greatest phytoextraction for only two of the metals tested. For the rest of the metals, Russian olive's phytoextraction was either not statistically different, or was significantly lower than that of the poplar genotypes.

Implications for the Future

- Based on the results of this study, hybrid poplars are a viable alternative to Russian olive for incorporation into agroforestry systems on saline soils.
- Research may expand upon this study with:
  - A mass balance assessment of the ultimate fate of metals in plant-based systems on saline soils
  - Tests to determine salt tolerant species from other plant functional groups (grasses, shrubs, etc.)

Sources

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Corresponding Author

Ronald S. Zalesny Jr.

USDA Forest Service
Northern Research Station
Rhinelander, WI, 54501
USA

+1 (715) 362-1132

ron.zalesny@usda.gov

https://www.nrs.fs.fed.us/people/Zalesny