Tree improvement and seed source monitoring:

operational production of hardwood seedlings in the eastern USA

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Evelyn (1664)[12] discusses genotype and seed selection: *"…as to what concerns the election of your Seed, It is to be consider'd, that there is vast difference in Trees even of the same growth and bed, which I judge to proceed from the variety and quality of the Seed… and therefore chuse not your Seeds always from the most Fruitful-trees, which are commonly the most Aged, and decayed; but from such as are found most solid and fair…"*

Background

Successful plantation establishment depends on many factors, including seedling quality, matching species to the appropriate site, and the silvicultural practices employed. Given the tremendous genetic variation in forest tree species, the origin of plant material is one of the most important factors in successfully establishing plantations.

Tree improvement in conifers and hardwoods grown for fiber and energy is common; however, there is little incorporation of these practices into the production of high quality hardwood species. We aim to identify the degree to which tree improvement, particularly for species grown for timber and veneer products, is being practiced at an operational level in hardwood seedling nurseries in the eastern USA.

Tree Improvement

Improvement of conifer species and poplar (*Populus* spp.) has significantly increased plantation productivity, tree form, wood quality, and pathogen resistance[2,3,4].

Fine hardwoods (e.g., black walnut (*Juglans nigra* L.) and northern red oak (*Quercus rubra* L.)) are grown for timber and veneer in eastern North America. Both are major components of the Central Hardwood Forest Region. Veneer grade black walnut lumber has historically been among the most lucrative forest products in the region and for this reason has been the focus of many tree improvement programs. These programs have yielded increased black walnut growth[5,6,7,8] and survival[8].

What is tree improvement?

Tree selection, evaluation and breeding for more desirable characteristics[1]

Seed Source Monitoring

Use of seed geographically adapted to a specific region can increase resistance to pest and pathogen damage[9] and yield higher seedling survival and better performance[8,10]. Extensive guidelines for transfer of conifer seed and seedlings exist in much of the USA, and were developed based on climatic data[10,11] as well as geographic and genetic information[11]. Less information is available for hardwoods, although provenance testing resulted in recommendations that black walnut can be moved northward as much as 322 km without risk of cold damage[6,8]. However, there are few examples of operational seed source regulation for hardwood species in the eastern USA.

Methodology

A questionnaire was mailed to plant material providers in the eastern USA (Figure 1) requesting information on their use of improved material and seed sources in operational hardwood seedling production.

Findings

- 52 completed questionnaires were returned (response rate of 51 %), representing almost 70 million hardwood seedlings produced/year
- < 20 % of improved hardwood seedlings are fine hardwoods (Figure 2)
- 27 % of respondents do not identify seed zones for their hardwood seedling production, and of those that do, 20 % make no attempt to ensure that seed collection corresponds to the intended outplanting zone
- Most respondents stated that use of genetically improved materials would benefit forestry in their region (Table 1); however, less than 40 % have germplasm in tree improvement programs
- While 64 % of respondents stated that they intend to use more genetically improved hardwood material in the next 10 years, only 48 % have tree improvement programs from which improved material is not yet available

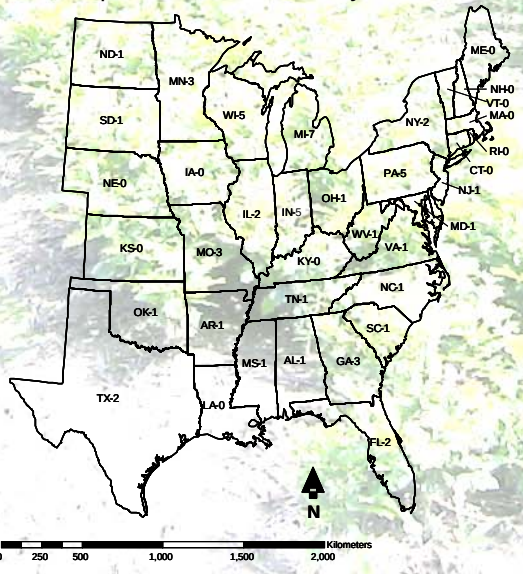

Figure 1. Number of respondent nurseries by state in the eastern USA

Only 6.8 % of hardwood seedlings produced are from improved materials, compared to 36.5 % of conifer seedlings at the same nurseries

Table 1. Perceptions of seed zones and genetic improvement

Do you see…	Yes, for timber production (%)	Yes, for ecological restoration (%)	No (%)
hardwood seed zones as beneficial to forestry in your region?	**53**	**59**	**25**
genetically improved hardwood nursery stock as beneficial to forestry in your region?	**77**	**38**	**10**

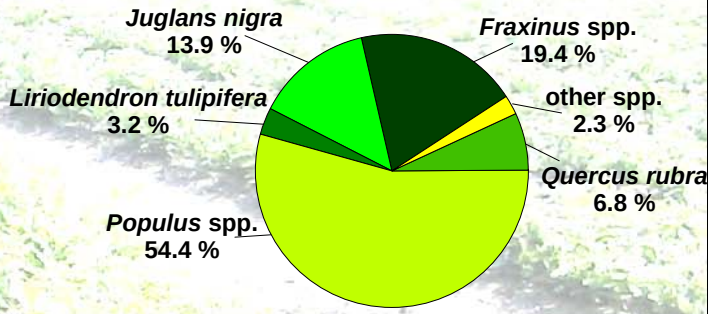

Figure 2. Proportion of tree improvement by hardwood species

Conclusions

- Hardwood tree improvement is not extensively practiced at an operational level
- Fine hardwood species represent only a small percent of improved hardwood seedling production
- Increased attention to incorporating tree improvement into operational hardwood seedling production is needed
- Nursery managers view seed zones as beneficial to forestry
- From the perspective of nursery managers, genetic improvement is seen as more beneficial to timber production than to ecological restoration
- Increases in production of improved seedlings will likely be limited by availability of improved plant materials
- Present levels of improvement appear insufficient to meet future demand

References [1]Ordre des ingénieurs forestiers du Québec 2003. *Dictionaire de la foresterie - Dictionary of Forestry - Diccionario de foresteria*. M. Côté (Ed.). Distribution de Livres Univers. [2]Robison, D.J. & Raffa, K.F. 1998. *Biomass and Bioenergy* 14, 1-20. [3]Li, B., Mckeand, S., & Weir, R. 1999. *Forest Genetics* 6, 229-234. [4]Schultz, R.P. 1999. *New Forests* 17, 71-88. [5]Bey, C.F. & Williams, R.D. 1974. *Indiana Academy of Science Proc.* 84, 123-127. [6]Bey, C.F. 1980. *J. For.* 78, 640-645. [7]Rink, G. 1984. *For. Sci.* 30, 821-827. [8]Bresnan, D.F., Rink, G., Diebel, K.E., & Geyer, W.A. 1994. *Silvae Genet.* 43, 246-252. [9]Macdonald, B. 1986. *Practical woody plant propagation for nursery growers*. Timber Press, Portland, OR. [10]Schmidling, R.C. 2001. *USDA Forest Service Gen. Tech. Rep.* SRS-44. [11]Randall, W.K. & Berrang, P. 2002. Washington tree seed transfer zones. *Washington State Dept. Nat. Res.* [12]Evelyn, J. 1664. *Silva, or a Discourse of Forest-Trees, and the Propagation of Timber in his Majesty's dominions.*