

Hybrid Poplar for Bioenergy and Biomaterials Feedstock Production on Appalachian Reclaimed Mine Land

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Introduction

Use of Appalachian mined lands for biobased products could help increase energy security, enhance the rural economy, and enhance the environment without displacing land for food production. However, achieving a sustainable biomass-based industry is contingent on the breeding, testing and selection of dedicated perennial cellulosic energy crops specifically for this region.

Poplars (genus *Populus*) and their hybrids are widely considered to be the premier woody perennial candidate for bioenergy feedstock production (De La Torre Ugarte et al. 2003; Perlack et al. 2005). Poplar plantation silviculture is highly refined and commercial stands have been successfully managed through multiple rotations by the pulp and paper, timber, and the environmental-remediation industries in a number of regions throughout North America. Hybrid poplar offers several important advantages including: 1) poplars are the fastest growing temperate zone tree with growth rates approximating 20 bone dry metric tons per hectare per year (total biomass) achieved on six-to-eight year rotations in commercial plantations of the Pacific Northwest (Stanton et al. 2002); 2) biomass can be stored “on the stump”. It can be harvested year-round and, therefore, does not require the same level of investment in drying and storage facilities necessitated by herbaceous energy crops to prevent microbial degradation (Wright 1994); and 3) The net effect of poplar cropping systems on greenhouse gas emissions compares very favorably to those of other cellulosic crops owing to their less frequent tillage and cutting cycles (Adler et al. 2007).

Although hybrid poplar has not been developed specifically for Appalachian reclaimed mine lands, there is strong evidence supporting that it can be a productive energy crop for these regions. For example, a four-year study on reclaimed mine lands in Virginia, Ohio and West Virginia compared hybrid poplar clone 52-225 (*Populus trichocarpa* x *P. deltoides*), mixed Appalachian hardwoods, and Eastern White Pine (Fields-Johnson et al. 2008). On all sites, the hybrid poplar had superior growth, with 72 times more biomass than the hardwoods and 39 times more than pine.

Experimental Approach

Our specific objectives are to: (1) Field test 98 clonally replicated genotypes of three major inter-specific taxa at the Powell River Project (PRP) site and two sites in the Southside region, and (2) To provide education and training to farmers and landowners, and inform potential investors and other interested parties, we will host a “Hybrid Poplar for Bioenergy” symposium at the Institute for Advanced Learning and Research in Danville, VA and workshops at the field sites.



Figure 1. Hybrid poplars on a reclaimed mine site in Wise County, Virginia, in their 6th growing season.

The intent of the trial is to provide the earliest scientific data on superior varieties for commercial biomass production in this region. First, we will identify the correct suitability ranking of the taxa based on their growth rate and adaptability to the climate, soil, and pathogen pressure of the planting sites. Secondly, we will assess the range of genotypic variation within taxa as a preliminary assessment of the potential genetic gain that will attend a long-term reciprocal recurrent hybridization program for Appalachian reclaimed mine land and Piedmont.

Trials were established in Spring 2009. Ten inch dormant stem cuttings were planted at a 10 feet X 2 feet spacing in a randomized block design with four replications per site. Clones (Table 1) were blocked by taxa with border rows for each block. Following second year varietal evaluation, above-ground biomass will be harvested and analyzed (2010), and coppicing ability of the varietals assessed (2011). Initial crop production (growth and yield) models will be developed. Results from these trials will be utilized to select varietals for yield verification studies that will confirm selections of superior first-generation commercial varietals.

Table 1. Summary of hybrid poplar clones being evaluated

Taxon	Number of Experimental Clones
<i>Populus x generosa (P. deltoides x P. trichocarpa)</i>	33
<i>Populus x Canadensis (P. deltoides x P. nigra)</i>	32
<i>Populus deltoides x Populus maximowiczii</i>	33
Total	98



Figure 2. Preparing the experimental site in December, 2007. The large disk (left) is used first to break up the sod, then an advanced ripping device (right) was used to prepare the land for planting. See Evans et al. (2009) for further details.

Progress at the Powell River Project Site

The planting site is located on top of a hollow fill that was constructed by coal mining operations in the early 1990s. The site had been reclaimed with herbaceous vegetation in accord with standard coal mine reclamation practices for that time. The site was released from all regulatory obligations prior to current research activities.

By December of 2007, vegetation had become a mix of herbaceous and invasive woody vegetation. A few native hardwood trees had been planted on parts of the site for research/demonstration purposes in earlier years but were not thriving, possibly due to deficiency of essential nutrients. The site was prepared using deep tillage in December of 2007 (Figure 2) using the same implements and procedure described by Evans et. al. (2009).

In March and April of 2009, the site was prepared for the research planting. Four blocks were prepared, each comprised of 5 rows (3 interior rows for the test planting, and 2 exterior rows for the border planting) at 9-to-10 foot spacing and approximately 90 feet in length.



Figure 3. The hybrid poplar test site at Powell River Project Research and Education Center in Wise County, Virginia, 15 August 2009, 3 ½ months after planting.

The surface created by deep tillage was irregular, with mounds and depressions evident in some areas. Surface soils were redistributed manually as needed to prepare regular planting rows over the deep rips but with fewer differences in microtopography than the tilled surface. The surface reconfiguration was intended to assure that none of the test plantings were in depressions where water would accumulate in these poorly-drained minesoils, as observations of prior plantings indicated that such microsite conditions depress hybrid poplar survival and growth.

The site was limed using pelletized limestone with a hand-operated broadcast spreader based on soil test recommendations to pH 6.8. (2 tons/acre rate for Block 1, 4 tons/acre rate for Block 2, 3 tons/acre Blocks 3 and 4). Triple super phosphate fertilizer (0-45-0) was applied using a hand-operated broadcast spreader, achieving an average rate of 81 lbs. P per acre over the planting area. Additional fertilization (18-9-8) was applied in an 24-inch band over the planting rows with a hand operated drop spreader with the intention of applying 25 lbs. N per acre, averaged over the planting-row bands and intervening spaces; actual application was about 30 lbs N / acre plus associated P and K. The N fertilization was confined to a band application with the intent of limiting herbaceous competition within the test planting.

A glyphosate herbicide was applied to visible vegetation within the planting rows approximately 20 hours prior to the hybrid poplar planting. The site was planted on May 1, 2009

[survivability was high during the establishment phase (Figure 3, Table 2). Manual weed control was applied periodically to the planting site over the summer.

Table 2. Early survival of trees at the PRP test site assessed on May 20, 2009

Rank	Test trees (percent)
Bud flushed, good vigor	93% (n=366)
Bud flushed, poor vigor	3% (n=13)
No bud flush	4% (n=17)

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References

- Adler, P.R., Del Grosso, S.J., and Parton, W.J. 2007. Life-cycle assessment of net greenhouse-gas flux for bioenergy cropping systems. *Ecol. Applic.* 17: 675-691.
- De La Torre Ugarte, D. G., Walsh, m. E., Shapouri, H., and Slinsky, S. P. 2003. The economic impacts of bioenergy crop production on U. S. agriculture. U. S. D. A. Office of Chief Economist, Office of Energy Policy and New Uses. *Ag. Econ. Rpt. No. 816*, 41 p.
- Evans, D.M., C.E. Zipper, J.A. Burger, and C. Fields-Johnson. Use of Reclaimed Mined Land for Woody Biomass Production: Installation and Year One Results. p. 35-43, in: 2009 Powell River Project Research and Education Reports. http://www.cses.vt.edu/PRP/Reports_09/Reports_09.html
- Fields-Johnson, C, D Evans, TR Fox, JA Burger, CE Zipper. 2008 National Meeting of the American Society of Mining and Reclamation, Richmond, VA, *New Opportunities to Apply Our Science* June 14-19, 2008. R.I. Barnhisel (Ed.) Published by ASMR, 3134 Montavesta Rd., Lexington, KY 40502
- Perlack,R.D., Wright,L.L., Turhollow,A.F., Graham,R.L., Stokes,B.J., and Erbach,D.C. 2005. Biomass as Feedstock for a Bioenergy and Bioproducts Industry: The Technical Feasibility of a Billion-Ton Annual Supply. Oak Ridge National Laboratory, Oak Ridge, TN.
- Ranney, J. W., Perlack, R. D., Trimble, J. L., and Wright, L. L. 1985. Specialized hardwood crops for energy and fiber: status, impact, and need. *TAPPI* 68: 36-41
- Stanton, B., Eaton, J, Johnson, J., Rice, D., Schuette, B., and Moser, B. 2002. Hybrid poplar in the Pacific Northwest: The effects of market-driven management. *Journal of Forestry* 100: 28-33.
- Wright, L. L. 1994. Production technology status of woody and herbaceous crops. *Biomass and Bioenergy* 6: 191-209.