Observed yields of poplars in the North Central United States greatly exceed previous observations

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Cottonwoods and their inter-specific hybrids (referred to collectively as "poplars") could augment traditional supplies of fiber and biofuels in the North Central and Northeastern United. However, yields of intensively managed poplar plantations in the east have always been lower than yields demonstrated in the Pacific Northwest. For example, a mean annual above ground biomass increment of 27.8 dry Mg $ha^{-1} y^{-1}$ (stem and branches) by a hybrid between *Populus deltoides* Marshall and *P. trichocarpa* Torr. & Gray was reported in the State of Washington over 15 years ago. [1] In comparison, yields of poplars derived from various inter-specific hybridizations did not exceed about 8.8 Mg $ha^{-1} y^{-1}$ in a multi-location testing experiment in the North Central U.S. [2] Yields of about 10.0 $ha^{-1} y^{-1}$ have been recorded in the North Central Region in irrigated stands of hybrid poplars at approximately the same age (4 yrs) and spacing (1.2m x 1.2m) as those producing the high yields in the Pacific Northwest.

Unfortunately, demonstrated yields are out of proportion with the amount of land suited to short rotation woody crops within the two regions. Acreage suited to poplar plantings may be 1,000-fold greater in the North Central than the Northwest. Clearly, it is in the national economic interest (with regard to the supply of feedstock commodities) and in the global environmental interest (with regard to potential sequestration of atmospheric CO_2) to eliminate the disproportionate relationship between potential yield and available land base. Yields of intensively managed poplar plantations in the North Central region must be increased to accomplish this goal. Our R&D goal is taken directly from a statement by a leader in the Department of Energy's Bioenergy Feedstock Development Program (BFDP) that "yields in excess of 7 tons per acre per year (about 15.7 Mg $ha^{-1} y^{-1}$) will be required by the year 2020 if woody crops are to make a significant contribution to the energy supply in the U.S.". [4] This report documents the first evidence that the objective of 15 Mg $ha^{-1} y^{-1}$ tons per acre per year is achievable in the North Central U.S.

Our results are taken from two series of genetics experiments conducted in the North Central U.S. Genetics research is a heavy R&D emphasis in our region because it is one method by which crop yields may be increased and a more diverse array of clones may be deployed commercially. The first series of experiments is a regional clone testing program where new selections are tested at several locations in the region using multiple replications of two-tree plots. Repeated annual measures of tree diameter have been made within the clone trials established in 1995. Diameter measurements were converted to individual tree biomass estimates using a general equation and mean annual increments (MAI) were estimated for all clones at the Minnesota, Iowa, and Wisconsin test sites. MAI of the best clone (7300501) at the Iowa test site (16.8 Mg $ha^{-1} y^{-1}$) exceeds MAI of the commercial control clones by over 100% and clearly exceeds the Bioenergy Feedstock Development Program goal. MAI of the best clone at the Wisconsin test site (17.0 Mg $ha^{-1} y^{-1}$) is even higher. Growth is much lower at the Minnesota site, which is directly attributable to soil quality at that site rather than to any regional climatic effect. The trend in basal area (BA) relative growth rate (m^2 increment /m^2 standing BA) has shown an interesting upward trend during the sixth growing season for all pedigrees at all test locations. Thus, we see no evidence that growth rate is beginning to decline at our test sites, and strongly suspect that MAI curves should continue to increase over the next year or two (at least).

The second series of experiments is a collection of poplar plantations in Wisconsin, Minnesota, North and South Dakota established between 1987 and 1992. The plantings contain poplars from earlier breeding programs in the Northeast United States and clones originally bred in Europe. Clones are represented at each site by unreplicated 16-tree plots. A new clone (DN 177) not previously selected for commercial deployment when the tests were 4 years old has a very high MAI at age 12 years with an average yield across 4 test sites of 15.0 Mg $ha^{-1} y^{-1}$. This clone produced an MAI at one site of 19.0 Mg $ha^{-1} y^{-1}$ comparing very favorably with the yield targets set by Department of Energy and the Bioenergy Feedstock Development Program.

Overall, it is clear that the Bioenergy Feedstock Development Program goal is achievable, perhaps sooner than 2020, based on our observation of growth in the Regional Field Test Program. And, this report represents a landmark achievement. Yet, certain research needs remain. For example, we do not yet know: (1) how yield estimates from small (2-tree) plots relate to growth and yield of the same clones in larger monoclonal blocks, (2) whether our general biomass equation applies without bias to the estimation of the dry weights of trees from newly developed genotypes, (3) how many clones exceeding 15 Mg $ha^{-1} y^{-1}$ will be identified in our ongoing testing program or (4) how many clones are required to ensure a sustainable feedstock production system. We hope to answer at least some of these questions over the next 5 years.

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[4] Downing, M.E. Verbal communication.