

Early Tree Growth in Brown and Gray Mine Soils Compared to Growth in Native Forest Soils¹

K. Dallaire and J. Skousen^{*2}

Abstract: Surface coal mining in Appalachia disturbs hundreds of hectares of land every year thereby removing valuable and ecologically diverse eastern deciduous forests. Reforestation of these areas after mining is an important step to helping restore ecosystem functions and land value. During reclamation, brown and gray sandstone materials were often placed on the surface as topsoil substitutes rather than native topsoil. Studies show brown sandstone substitute materials (mine soils) promote better tree growth because of lower pH, higher percent fines, and higher available nutrients than gray sandstone, but few field studies have compared tree growth on brown and gray mine soils to undisturbed forest soils. This study evaluated the height growth of red oak (*Q. rubra* L.), white oak (*Quercus alba* L.), and tulip poplar (*Liriodendron tulipifera* L.) on two mine soil types compared to the height growth on native soils from clear-cut areas at the Fernow Forest, WV, and from heights based on site indices (SI) of native soils prior to mining. At both mine sites, brown sandstone and gray sandstone plots (with a mulch treatment) were constructed and 12 tree species were planted and measured for growth annually for 11 yrs. Soil properties were also determined. The pH of brown sandstone was 5.2 to 5.4, gray sandstone was 6.5 to 6.8, mulch treatments were 7.0, and native soils were 4.1 to 5.2. Percent fine soil particles ranged from 42 to 60% on mine soils and mulch-treated mine soils had higher levels of Ca (197 cmol_c kg⁻¹), K (12 cmol_c kg⁻¹), and Mg (12 cmol_c kg⁻¹) compared to other soils. After 11 yrs., tree heights on gray sandstone were significantly lower (0.5 to 0.9 m) than tree heights in brown sandstone (2.8 to 3.6 m) for all three species. Trees on mulched mine soils were up to 0.7 m taller than trees on un-mulched brown mine soils. Red oak grew an average of 0.43 m per yr. on native soils in the Fernow Forest compared to 0.27 to 0.32 m per yr. in brown and mulched mine soils. Tulip poplar grew between 0.5 and 0.85 m per yr. in the Fernow compared to 0.24 to 0.44 m per yr. on brown mine soils. For oaks, average annual tree growth in mine soils was about 30-50% of that calculated from pre-mining native soils and about 70% of that from tree height in Fernow clear-cut areas. Tulip poplar on brown mine soils was only 30% the height compared to pre-mining native soils and 50% the height of trees in the Fernow Forest. In gray mine soils; trees were not growing at all. While the trees in brown mine soils are growing, tree growth has not yet reached levels of tree growth in native soils the first 11 yrs. after planting. Evolving mine soils may develop properties over time that are similar to native soils and, with the increased rooting depth, may provide conditions where increased growth rates and SI may be attained.³

Additional Key Words: land reclamation, red oak, reforestation, soil compaction, tulip poplar, white oak

1. Oral paper presented at the 2019 National Meeting of the American Society of Mining and Reclamation, Big Sky, MT. Welcome Back to Montana: The Land of Reclamation Pioneers, June 3 - 7, 2019. Published by ASMR; 1305 Weathervane Dr., Champaign, IL 61821.
2. Kara Dallaire, Paragon Soil & Environmental Consulting, Edmonton, Alberta, CA; Jeff Skousen, (* presenter). West Virginia University, Morgantown, WV, USA jksousen@wvu.edu, 304-293-2667.
3. Work reported here was done at Catenary Coal 38°5'28" N, 81°26'37" W, and at Arch Coal 38°25'31.74" N, 80°36'39.74" W.