American Sycamore As a Biomass Species

The Beginning Of a Great Future

A mature American sycamore is beautiful, with its large crown of maple-like leaves and mottled, white and green-gray exfoliating bark. As a young seedling, sycamore quickly out-competes all but the fastest-growing species, such as eastern cottonwood and black willow.

Sycamore was once considered one of the most promising hardwood plantation species in the southeastern United States. This tree possesses all the characteristics needed for a great biomass species: high survival rates, fast growth, medium wood density, excellent coppice ability (ability to stump sprout), and very thin bark (Isenburg 1981).

In addition, sycamore grows well in plantation culture, though it is rarely found in large stands. Sycamore is typically found in mixed stands, along with other intermediate shade-tolerant species and intolerant and shade-tolerant species. Sycamore grows largest on floodplain alluvial soils of major rivers and in bottomlands (Wells and Schmidtling 1990).

If both nutrients and moisture are in good supply, it is capable of growing over 7 feet per year on these types of soils (Figure 1). Studies have shown that sycamore can grow over 10 feet per year in the mid-South given the right amounts of nutrients and water (Figure 1). However, if either fertility or moisture limits their growth, sycamore will quickly stagnate.

Like other shade-intolerant hardwood species, young sycamore will suffer greatly from herbaceous and vine competition. Control perennial vines when preparing the site. Glyphosate (Roundup) and triclopyr (Garlon 4) can be used before sycamore establishment but must be sprayed on the leaves of the vines. Triclopyr can control a greater variety of vines. Imazapyr (Arsenal) can also be used but must be done at least 6 months before planting. After planting, controlling competing vegetation with herbicides is difficult because only a few chemicals work against competing vegetation without damaging sycamore seedlings. To date, the primary herbicide used is oxyflurofen (Goal 2XL), which is applied

Figure 1. 5-year-old sycamore progeny test on an irrigated plantation near Benton, MO (left) and 2-year-old operation sycamore plantation on a Mississippi River alluvial site near Hayti, MO.

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Figure 2. Drip irrigated and fertilized sycamore plantation near Benton, MO: (left) First-year sycamore growth and (right) early stump sprouting following a harvest of an 8-year-old plantation.

as a pre-emergent. Disking, which is a form of mechanical cultivation, is usually necessary the first year because of herbicide limitations. Therefore, plantation layout should allow tractor access.

Plantation sycamore has also been grown under drip irrigation systems, where both water and liquid fertilizer are fed through an emitter placed alongside the seedling (Figure 2). Growth was extremely rapid through the first 8 years (unpublished MeadWestvaco data), indicating that sycamore in an ideal situation has greater growth potential than expected. In addition, healthy young sycamore produces coppice soon after harvest (Figure 2).

Plantation Culture of Sycamore

In addition to its rapid early growth, sycamore also has medium wood density (average specific gravity is 0.46), excellent coppice ability, thin bark, and ability to grow on a range of sites (Isenberg 1981). Some of the best plantations have been located on alluvial soils of the Mississippi River where soil-site relationships were well matched. Like all hardwoods, sycamore must be correctly matched to the site. Sycamore performs poorly on sites that are poorly drained, extremely dry, or lacking nitrogen.

To prepare a site for sycamore after a natural hardwood stand has been harvested, shear, rake, and burn. Follow with a chemical application to control vines and any other perennial competition. Disk the site to break up any material that would hinder mechanical cultivation. Subsoil the site in at least one direction so that disking after planting will be possible. Subsoil old field sites to shatter any type of plow pan or fragipan, allowing easier planting and greater root expansion. Be sure to purchase quality seedlings. Find out the geographic origin of the seed and whether the nursery produces quality seedlings reliably. Look for the following seedling standards:

- minimum root collar diameter of 3/8 inch,
- 4 to 8 first-order lateral roots (the thick roots that extend from the taproot),
- an 8- to 10-inch taproot, and
- an 18- to 24-inch branched top. (This type of top offers ample leaf area for photosynthesis, providing food to the seedling for early growth.)

Grade your seedlings before going to the field to insure that only high-quality seedlings are planted (Rousseau 2010). Site preparation and seedling quality play a key role in survival and growth. Also, be sure the trees are not root pruned, the seedlings are planted deeply, and the soil is packed tightly around the roots.

The Decline of Sycamore

Sycamore was once considered one of the most promising hardwood plantation species of the southeastern United States. It was planted by a number of pulp and paper companies throughout the Southeast in the 1970's and 1980's. But it began to exhibit disease problems in the mid-1980's, and many trees died. In the 1990's, several groups began to investigate the reasons behind the widespread mortality and discovered that it was caused by a complex of three diseases. Those diseases are bacterial leaf scorch (*Xylella fastidiosa*), canker stain fungus (*Ceratocystis fimbriata*), and Botryodiplodia sycamore canker (*Botryodiplodia theobromae*) (Henneberger et al. 2004). To date, there are no known genetic sources of resistance to this disease complex. By the time the problem was classified as a disease complex in the 1990's, sycamore had been eliminated as a plantation species.

One of the most visible diseases is sycamore anthracnose, which is typically observed during cool, wet weather (temperatures under 60 °F) during budbreak or within a few weeks of early growth. This disease can completely strip a tree of its leaves. Its most obvious symptom is many small shoots growing

in the area the disease girdled the branch. Rain and wind spread spores (reproductive structures) from the fungus to healthy leaves, buds and twigs. The fungus survives the winter on fallen leaves and twigs as well as on cankers present on twigs that remain on the tree. While this disease does limit growth, it does not typically result in mortality.

A Renewed Interest From Genetic Solutions

Today, the use of biomass for bioenergy and biofuels has created new interest in short-rotation culture of sycamore. The promise of a hardwood that grows quickly and can be planted on a variety of sites has generated interest in solving the problem of sycamore's disease susceptibility. Developing disease-resistant, open-pollinated seedlings in a typical seed orchard would be extremely difficult because pollen from wild stands could pollinate the resistant genotypes and result in unknown levels of resistance. To get the disease resistance needed, either pollination would have to be controlled or resistant genotypes would have to be cloned. Control-pollinations would be a little more difficult, but a single cross could produce enough seedlings for a substantial annual planting program. However, this technique has not been tried on a large-scale basis. Specific breeding techniques, such as early flowering, may allow easier control-pollinations and lower the cost of producing resistant seedlings. Cloning sycamore using vegetative propagation could result in disease-resistant cuttings. The production of unrooted, disease-resistant cuttings would be the ultimate propagation technique, as it would result in genetically identical, disease-free plants.

Conclusion

American sycamore holds great promise as a suitable hardwood plantation species for either pulpwood or biomass production. However, disease problems have become a major barrier to the use of this species. To overcome this disease problem, it is important to use a selection strategy that will combine the production of seedlings and cuttings through the use of full-sib selection and clonal production.

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Publication 2636
Extension Service of Mississippi State University, cooperating with U.S. Department of Agriculture. Published in furtherance of Acts of Congress, May 8 and June 30, 1914. GARY B. JACKSON, Director
(POD 12-10)