SPACING AND CUTTING CYCLE INFLUENCE ON SHORT ROTATION SILVER MAPLE YIELD

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Field studies showed that silver maple trees grown at close spacings produced annual dry-weight-wood yields of 4 tons/acre, even after numerous coppice cuttings over an 8-year period. Annual yields were higher with a longer cutting cycle.

Silver maple (*Acer saccharinum* L.), one of many fast growing coppicing hardwood species, has great potential for producing fiber rapidly under the "silage-cellulose" management concept (*5*). Hardwood trees, when closely spaced and intensively managed, have the potential to produce supplemental fuel for solid-waste refuse-energy systems or feed for cattle, besides the more typical fiber products.

Biomass yields of woody plants are high (*3*) under some situations, but before a "silage" concept can be adopted, yields must be established locally and questions not commonly considered in conventional forestry answered.

This report presents findings on coppice yields of close-planted silver maple on a good bottomland site in eastern Kansas.

WHAT WAS DONE

In 1968 silver maple was planted on alluvial soil below Tuttle Creek Reservoir near Manhattan. Other species, including cottonwood, are being tested at several locations in eastern Kansas. Only silver maple was planted in 1968.

The soil has a silty-clay to silty-clay loam texture, a pH of 7.5, 2.0 percent organic matter, 130 pounds available phosphorus, and 500 pounds exchangeable potassium per acre. Highly productive for field crops, the land had been farmed for about 10 years prior to this experiment. Annual precipitation here is 33.5 inches, primarily during the growing season.

Nursery-run 1-0 seedlings from Missouri were hand planted in late April at three spacings: 1 x 1 ft, 1 ½ x 1 ½ ft, and 2 x 2 ft. Six replications of each spacing were randomly installed on 6 x 6 ft plots with 4-ft borderstrips. Three border rows of trees surrounded the study area. Throughout the experiment, weeds were controlled by hand cultivation. Total height and survival were determined each year; sprouting characteristics were noted starting with the fifth year.

Half of the plots were cut the second year and half the third year. During succeeding harvests all plots were cut the same day. The first 2-year yields were determined (dormant cut) from nondestructive sampling measurements of average dominant trees. Volumes were calculated from numerous bole-diameter measurements and expanded appropriately. Weight yield was calculated from specific gravity determination by destructive sampling of a few border trees. Three 1-year coppice and one 2-year coppice yields were determined after the third growing season cut.

Specific gravity, percent moisture and fuel value were taken from samples collected as the plots were clear cut. Standard procedures were used: specific gravity, oven dry (OVD) weight at 100° C and displaced water green volume; percent moisture on a fresh weight basis; and BTU with a Parr adiabatic bomb calorimeter. The trees cut 2 or 3 inches above the ground were used in their entirety—bark, wood, and buds.

WHAT WAS FOUND

Survival was 100 percent for all spacings after the first growing season; it dropped to about 76 percent by the second, 48 percent by the fourth, and 35 percent by eighth (table 1). Dominant trees were tallied after the fifth growing season, by which time their number approached one-third the original number of trees planted. After the eighth year, about six trees were found dominant at each spacing; thus, indicating competition among trees will soon (after 4 or 5 years) leave about the same number of strong individuals growing on each plot regardless of the original spacing. During the 8 years of testing, neither insects nor diseases were noticed in the stand.

Trees spaced 1 foot apart yielded a higher tonnage than did the others, especially during the first 2 years (table 1). Apparently, during the third year competitive dominance had been established and the site was fully used, regardless of the spacing; that was

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Table 1. — *Survival and annual growth of short rotation silver maple by year*

Years[1]	No. growing seasons	Survival by spacing (ft) 1^2	1.5^2	2^2	Annual growth rate by spacing (ft)[2] 1^2	1.5^2	2^2
		-----percent-----					
1	1	100	100	100	2.1	0.6	0.4[3]
2	2	73	68	88	3.9	2.6	1.8
3	3	61	56	81	5.2	4.0	5.1
4	1	39	40	66	2.5	1.5	2.3
5	1	41	48	62	4.0	3.7	4.8
6	1	37	40	56	3.2	2.8	3.4
8	2	29	28	50	5.7	4.8	6.6

[1] Cut and weighed after 2d, 3d, 4th, 5th, 6th, and 8th year.

[2] Annual growth by actual cut and weighed plot yield, except first year by selective tree size measurements. Yield 2d and 8th year based upon 2-year mean growth weight.

[3] Spacing significantly (95 percent level LSD) affected yield only during 1st and 2d years.

evidenced by nearly the same annual yield thereafter. Yearly and biennial coppice yields were about 4 tons/acre OVD weight annually. Resprouting, which continues to be vigorous on the living dominant stumps, shows no reduction in area yields even after 8 years' growth and five or six cuts. The low yield during the fourth growing season is explained by poor weed control.

The longer cutting cycles (1-, 2-or 3-year seedlings and 1- or 2-year coppice) increased the annual growth rate (table 1). The results are similar to those found for silage sycamore in both Mississippi and Georgia (*4, 6*) where spacings are wider (1 x 4 to 4 x 6 ft). At what age that trend will level off is not known, but the growth rate will most likely continue longer at the wider spacings. A projection model for the yield of a selected *Populus* clone in Wisconsin planted at the same spacings used in my study indicated that mean annual growth would peak between 8 and 15 years (*2*). A silage-management program on large areas, where only one species has been planted, may render the sprouts susceptible to insects and diseases normally not detrimental in usual management-cutting practices. Thus, the stand may be degraded and the yield may level off earlier than expected.

Tree and biomass characteristics are summarized in table 2. After the first growing season, annual height growth apparently

Figure 1. — *Silver maple stump sprouts at end of first coppice season. Dominating trees and sprouts numbered about the same after 4 or 5 years.*

was about 7 ½ feet.

Sprouting is prolific even after four cuts. Although the total number of sprouts may be high (20 plus) less than half can be considered dominant or vigorous. Figure 1 shows sprout size after one growing season. Growth is so vigorous on these soils during the second growing season that little light reached the ground and weed growth was negligible (figure 2):

Specific gravity, percent moisture, and heat of combustion (fuel value) are biomass characteristics of importance in this energy oriented age. The spe-

Table 2.—*Selected characteristics of average sample silver maple trees*

Characteristic		*Avg.*	*Range*	*Comment*
Total height (ft) of dominants				
Seedling	1st	3.5	2.5 - 4.0	1 growing season
Seedling	2nd	11.0	9.0 - 13.0	2 growing seasons
Seedling	3rd	16.0	15.0 - 18.0	3 growing seasons
Coppice	1st	7.0	5.5 - 8.0	1 growing season
Coppice	2nd	9.0	7.0 - 10.5	1 growing season
Coppice	3rd	8.5	7.0 - 10.0	1 growing season
Coppice	4th	8.0	7.0 - 9.0	Avg., 2 growing seasons
Stump sprouts from last 3 coppice cuts				
Total		18	6 - 37	Spacing no effect
Major		8	3 - 17	Same
Specific gravity		.407	.343 - .493	Stems, branches, bark, buds
Percent moisture		50.9	47.7 - 58.2	Fresh weight basis
Fuel value (Btu/lb OVD wt) Entire tree		8050	7999 - 8116	Coppice samples

Figure 2. — *The site was used completely by silver maple seedlings during the second growing season.*

cific gravity of sample trees cut during the dormant season averaged 0.41, which is lower than that commonly reported at 0.44 to 0.49 green wood (*1*). Sample trees included bark and buds.

Roughly half of the fresh weight of dormant cut trees is sap; thus all field weights need to be halved to find the oven-dry fiber content.

The fuel value of silver maple silage was about 8050 Btus per pound of oven-dry biomass, which included bark, wood, and buds. Normally reported values are 8,600 for wood and 9,000 British thermal units for bark. Thus maple silage apparently may be an important fuel source.

SUMMARY AND MANAGEMENT IMPLICATIONS

Results from this preliminary study on small plots show that high yields (4 tons/acre/year, dry weight) of fiber can be produced from both seedling tree and numerous coppice cuts of silver maple. Furthermore, even after five or six cuts during an 8-year period, yield did not deteriorate. Although fiber yield was higher for closely spaced than for more widely spaced trees the first 2 years, the yield was about the same in succeeding years.

Competitive mortality was high at the close spacings of 1 x 1 and 1 ½ x 1 ½ ft. After 4 or 5 years and a few cuts, the number of dominant trees and dominant sprouts on a stump was about the same, regardless of original spacing.

More wood was grown annually with a long cutting cycle than with a short. That proved to be true for both the original seedling growth and succeeding coppice cuts. Within the parameters of this study, on a good site, a 3-year cutting cycle apparently is best.

In this study the density of whole tree fiber was understandably lower than that reported for wood from large trees, but it was

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still reasonably high (0.41). And fuel value characteristics were high (8,050 Btu).

Results so far from this pilot study have prompted further studies at three additional sites, upland and bottomland. Additional research was initiated last spring to investigate short-rotation yields on upland sites to deter mine the possibility of providing silage wood as a fuel supplement for a large university heating plant.

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