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Coppice Growth of Sycamore and Sweetgum in Relation to Season of Cutting[1]

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伐木時期에 따른 양버즘나무와 Sweetgum 萌芽의 成長[1]

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ABSTRACT

Twelve-year-old rootstocks of sycamore and sweetgum were coppiced at monthly intervals for one year. Sprout growth was measured three and five years after cutting. After three years, average dry weight of the sprouts cut in May, June and July was lower by 36% for sycamore and by 24% for sweetgum than those cut during the other months of the year. However, these differences were reduced to be 23% and 14%, respectively, after five years.

Key words : short-rotation forestry, sprouting, dry weight

要 約

12년생 양버즘나무와 sweetgum을 대상으로 1년 동안 월별 벌목하고 3년과 5년 후에 맹아지의 성장을 조사하였다. 5, 6, 7월에 벌목 발생한 맹아지의 평균 건중량은 다른 달에 벌목 발생한 맹아지의 평균 건중량에 비하여 벌목 3년 후 양버즘나무는 36%, sweetgum은 24% 정도 적었다. 벌목 5년 후에는 그 차이가 각각 23%와 14%로 감소하였다.

INTRODUCTION

The coppice system for wood production exploits the ability of the stump of many hardwood species to reproduce successive crops of above-ground wood after harvesting the previous crop. Coppice refers to sprout regrowth from the stumps of cut trees which is characteristic of most broadleaved and a few coniferous species. Yields of coppice stands are high because the sprouts grow on a root system with previously established access to soil water and nutrients and with stored carbohydrate reserves which are cycled into the new growth (Steinbeck, 1983).

Coppice forestry is likely to become the major silvicultural system for producing pulp, firewood, extractives and minor forest products because it is the simplest and most dependable means of approaching the maximum average annual production theoretically attainable from a given species (Smith, 1986). Coppice forestry can be practised extensively, both in the sense of large land areas and of few cultural operations. Intensive coppice forestry is a relatively recent development and is now generally

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called short-rotation forestry. Short-rotation forests are plantations of closely spaced, broad-leaved trees which are harvested repeatedly on cycles of less than ten years. The key to higher production than that achieved under more conventional management systems depends on the stumps. Once established, they remain in the ground after each harvest of the above-ground tree portions, and resprout. The success of short-rotation forest management depends on sustaining high yields of coppice growth over successive harvest. Degree of sprouting, sprout growth and stump vigor, therefore, are primary considerations in the culture of coppice plantations.

In temperate forests, the most vigorous stump sprouts result when hardwoods are felled in winter. This has been shown to be the case for *Cornus florida* (Buell, 1940) and various *Quercus* species (Wendel, 1975; Lee *et al.*, 1997). Some *Eucalyptus* species stumps sprout poorly at certain times of the year (Webley *et al.*, 1986). However, in several *Quercus* species (Roth and Hepting, 1943) the percentage of stumps producing sprouts was uniformly high regardless of harvest season.

Seasonal cutting effects are especially important in short-rotation forestry (Steinbeck *et al.*, 1972). Pulpmills and power plants demand year-round wood supplies. Therefore the objectives of this study were to examine the coppice growth of sycamore and sweetgum in relation to season of cutting.

MATERIALS AND METHODS

This study was conducted on 16-hectare plots where three species growth and screening trial in Tattnall County, Georgia, USA were established in early 1978 and 1979. Bare-rooted, 1-0 seedlings of American sycamore (*Platanus occidentalis*) mixed with European black alder (*Alnus glutinosa*) in alternate rows and sweetgum (*Liquidambar styraciflua*) mixed with European black alder were planted at a 1.2×2.4 m spacing. The alder survived poor and was totally eliminated by disking three years after planting. Thus sycamore and sweetgum only were remained in pure plots at a 1.2×4.8 m spacing. The soils of the site were loamy, siliceous, thermic family of Arenic Plinthic (Fuquay soil series) and Plinthaquic (Leefield soil series) Paleudults. Half of the plots were fertilized in 1979 and 1981, which amendments did not affect the trees planted.

The chronology of the plantation was as follows : At the beginning of this experiment, rootstocks were 12 years old - one year in the nursery, five years of growth after transplanting to the field, initial coppice in early 1983 at age 6, and then coppice growth for another 6 years until February 1988. Over the next 12 months, a monthly harvesting schedule was initiated.

Five large plots for each species, randomly scattered through the plantation, were subdivided into 12 subplots consisting of 3 trees in each of 3 rows surrounded by at least one border row on each side. One cutting month of the year was assigned randomly to each subplot. Thus the statistical design was a randomized complete block with 5 blocks, two species, and 12 monthly cutting treatments.

Monthly cutting treatments were begun in February, 1988 and continued through January, 1989. Trees were cut at about 15 cm above the soil surface. Before the trees were cut, their heights and diameters at breast height were measured. The growth of the sprouts for five randomly chosen stumps in each subplot was measured three and five years later, again at monthly intervals corresponding to their cutting months. Dominant sprouts, defined as those in the upper 25% of the canopy, were measured, as well as all sprouts for each of the five rootstocks.

Prediction equations from DBH to estimate wood dry weight were developed from about 10 sprouts per 1cm DBH class for each species. A total of about 100 and 130 sprouts of sycamore and sweetgum, respectively, were harvested to measure their dry weights. The prediction equations for sycamore and sweetgum were $\log Y = 1.91 + 2.50 \log X (R^2 = 0.99)$ and $\log Y = 2.23 + 1.92 \log X (R^2 = 0.97)$, respectively, where Y was above-ground wood dry weight in grams and X, DBH in cm.

RESULTS AND DISCUSSION

Stumps of both species coppiced in November through April produced the best sprout growth (Tables 1 and 2). Sprout production declined following May, June, and July cuttings. Leaves produced in the first growth flush matured in May, probably leading to low carbohydrate reserves (Wenger, 1953) and lowered sprouting vigor. Stumps cut in August and later resprouted more vigorously. October was another unfavorable cutting month. This may be the result from winter kill of the initial set of sprouts which emerged right after cutting and were not ready to become frost hardy. That would have forced production of a new set for the following spring.

Less biomass was produced after cuttings during the entire May through July period than in the other nine months of the year. The significance of

Table 1. Growth of sweetgum stump sprouts in relation to cutting season.*

	Dominant sprouts		All sprouts		
Cutting month	Number	Mean DBH (cm)	Number	Basal area (㎠)	Dry weight (kg)
Three years after cutting					
Feb. '88	2.4	3.9	10.7	33.1	6.48
Apr.	2.7	3.8	9.6	34.1	6.64
Mar.	3.0	3.4	9.7	33.5	6.49
May	2.9	3.0	12.9	23.0	4.55
June	3.3	3.2	11.7	30.6	6.04
July	3.1	3.2	10.7	28.4	5.61
Aug.	3.4	3.2	11.6	29.5	5.83
Sept.	3.6	3.5	12.4	40.7	7.98
Oct.	3.2	3.3	11.9	34.0	6.66
Nov.	3.4	3.4	9.5	37.4	7.29
Dec.	3.0	3.7	13.3	38.4	7.50
Jan. '89	3.4	3.9	10.7	46.5	9.02
Mean	3.1	3.5	11.2	34.1	6.67
F-test significance level	5%	1%	5%	1%	1%
Five years after cutting					
Feb. '88	1.7	5.7	3.9	61.9	11.52
Mar.	2.0	6.1	3.1	75.6	13.94
Apr.	2.2	5.4	3.5	66.9	12.45
May	2.2	5.0	4.5	54.1	10.18
June	2.1	5.4	4.3	61.5	11.52
July	2.1	5.4	4.1	57.8	10.90
Aug.	2.4	5.2	5.3	63.7	12.07
Sept.	2.4	5.8	4.5	69.8	13.16
Oct.	2.3	5.2	5.4	59.2	11.26
Nov.	2.3	5.7	4.2	65.5	12.36
Dec.	2.2	5.8	4.4	68.5	12.90
Jan. '89	2.3	5.8	4.5	71.5	13.44
Mean	2.2	5.5	4.3	64.7	12.14
F-test significance level	NS	1%	1%	5%	1%

* Entries are means for all rootstocks.

Table 2. Growth of sycamore stump sprouts in relation to cutting season.*

Cutting month	Dominant sprouts		All sprouts		
	Number	Mean DBH (cm)	Number	Basal area (㎠)	Dry weight (kg)
Three years after cutting					
Feb. '88	3.2	2.2	14.2	16.8	2.46
Apr.	3.2	2.0	11.6	14.9	2.22
Mar.	3.5	2.1	12.1	16.3	2.48
May	4.2	1.8	12.9	12.4	1.78
June	4.2	1.7	13.8	12.9	1.93
July	4.9	1.5	14.8	11.8	1.62
Aug.	4.5	2.1	14.9	20.2	3.26
Sept.	3.9	1.9	11.5	17.0	2.67
Oct.	3.9	1.8	17.6	14.7	2.15
Nov.	3.8	1.9	17.2	16.4	2.51
Dec.	4.4	2.2	20.3	24.6	3.86
Jan. '89	4.4	2.0	18.4	21.6	3.41
Mean	4.0	1.9	14.9	16.6	2.53
F-test significance level	1%	1%	1%	1%	1%
Five years after cutting					
Feb. '88	2.0	3.2	3.7	24.1	4.95
Mar.	2.0	3.4	3.6	26.4	5.50
Apr.	1.9	3.3	3.3	23.4	4.90
May	2.3	2.9	4.5	23.1	4.53
June	1.9	3.3	3.9	22.5	4.45
July	2.0	3.1	4.3	22.2	4.18
Aug.	2.4	3.6	3.9	30.8	6.30
Sept.	2.4	3.6	4.7	30.9	5.96
Oct.	2.4	3.3	4.8	24.4	4.55
Nov.	2.3	3.3	3.9	25.7	4.94
Dec.	2.4	3.8	5.3	37.5	7.81
Jan. '89	2.3	3.6	5.0	31.2	6.20
Mean	2.2	3.4	4.2	26.8	5.36
F-test significance level	NS	NS	5%	5%	5%

* Entries are means for all rootstocks.

this trend was tested by pooling the means of the dry weights produced during this three months and compared to those produced in the other nine months. The differences were significant at the 1% for both species, indicating that cuttings in the entire 3 months adversely affected subsequent biomass production.

Reductions in sprout growth after May-July cuttings were the greatest in the first year following coppicing (Table 3). Sycamore yields were reduced by 40%, those of sweetgum by 23%. These differences continued, but became smaller over the years. Five years after cutting those had decreased to 23%

Table 3. Reduction in woody biomass yields following May-July cuttings.

	Number of years since cutting		
	One*	Three	Five
Sweetgum	-23%	-24%	-14%
Sycamore	-40%	-36%	-23%

* From Park and Steinbeck(1994)

and 14%, respectively. These reductions were much smaller than those observed by Belanger(1979) who cut sycamore saplings growing on a bottomland site in the Georgia piedmont. He found that, four years later, stumps cut in January and March produced 50% more biomass than those cut in May, and six times more than stumps cut in July.

An average sycamore stump supported more dominant and more total sprouts than the average sweetgum stump (Tables 1 and 2). While there were some statistical differences in the number of sprouts produced, the differences are too small to be of practical importance. About two-thirds of all sprouts died between ages 3 and 5. Most of them were small.

CONCLUSIONS

Cuttings during the period May through July resulted in significant reductions of sprout growth when compared to those following cuttings in the other nine months of the year. The degree of reduction varied with species and diminished over time.

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