UNDERPLANTING YELLOW POPLAR IN A SHORTLEAF PINE PLANTATION IN SOUTHERN ILLINOIS

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Abstract - Shortleaf pine planted in Illinois is growing at its extreme northern range in the Mississippi River Valley and has a reduced growth rate and life expectancy. Eventually, the pine in a large number of these plantations will either be harvested or die and be replaced with undesirable hardwoods such as cherry and sassafras unless some form of management is performed to direct species composition. The reproduction in a 32-year-old shortleaf pine plantation was manipulated by planting 1-0 yellow-poplar seedlings between rows of pine. Four years after yellow-popular was planted, the pine in various 0.2-ha plots were either (1) clear-cut, (2) cut to 13.8 m^2 of basal area, (3) cut to 23 m^2 of basal area, or (4) no pine were cut (control). Eight years after pine were cut, neither survival (average, 61 percent), diameter at breast height (average, 4.1 cm), nor percent of multiple stems (average, 24 percent) of the yellow-poplar was correlated with pine thinning treatments. The only significant difference in height of yellow-poplar was that those trees in the 23 m^2 plots were taller than those in the treatment plots. The tallest poplar was 9.4 m.

KEY WORDS: underplanting, *Liriodendron tulipfora* L.

About ninety percent of what are now the sixteen southermost counties in Illinois were orginally covered by hardwood forests. Many of these acres were cleared for agriculture but poor land use practices, coupled with high rates of erosion, demonstrated that some areas were unsuited for farming and they were eventually abandoned from agriculture.

Reforestation of these abandoned lands was begun in the 1930's but the site quality of most areas had deteriorated to such a degree that native hardwood species could no longer be grown successfully. A less demanding species, shortleaf pine (*Pinus echinata* Mill.) proved to be well adapted to these areas, although it was being planted at its extreme northern botanical range.

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Burkhart and Gilmore (1967) recommended that when shortleaf pine plantations in southern Illinois show signs of excess mortality and the growth rate is reduced at about age 25, the entire stand should be considered for harvesting. But when these stands are opened-up by thinning, cherry (Prunus spp.), sassafras (Sassafras albidum (Nutt.) Nees), and other less desirable hardwoods will normally take over the area (Arnold and Boggess 1971).

To insure a desirable new tree crop on these harvested areas in a minimum length of time, some method other than natural regeneration must be devised. Young et al. (1969) reported the results from an exploratory study where yellow-poplar (Liriodendron tulipfera L.) was underplanted in a shortleaf pine plantation. Their results were encouraging but because of small numbers of trees, small plots and lack of isolation strips between plots the results were open to question. They did demonstrate the possibility of establishing yellow-poplar under a shortleaf pine plantation and found that yellow-poplar could be planted a number of years before the pines are thinned. The present paper reports the results of a study that expanded on the work of Young by using larger plots, a more complete design and a different soil type. Data is given on survival and growth of yellow-poplar twelve years after the seedlings were planted and eight years after the overstory pine was thinned.

THE STUDY AREA

The study area is located in southern Illinois in the nonglaciated Shawnee Hills Section, an extension of the Ozark Mountains of Missouri (Leighton et al., 1948). The soil is a Grantsburg silt loam (Typic Fragiudalfs), an upland soil that developed under forest vegetation in about 127 cm of loess over sandstone bedrock. A well developed fragipan occurs in the soil throughout the study area. The structure and consistency of this impervious layer adversely affects both root penetration and downward movement of water. Percolation in the soil varies from 5 cm per hour in the upper 5 cm, to less than 0.3 cm in the fragipan. Texture above the fragipan is very similar throughout the area, averaging 12 percent sand, 63 percent silt, and 25 percent clay. Erosion had reduced the topsoil to about 8 cm. Bulk density of the soil was uniform, averaging 1.23 g/cc.

Annual rainfall averages 117 cm, 41 cm of this occuring during June thru September. July is the driest month during the growing season averaging 8 cm of rainfall (Page 1949).

Temperature in July averages about 27°C but coupled with low rainfall, a drought usually occurs during this month. The frost free season averages 195 days annually.

METHODS

One-year-old yellow-poplar seedlings from a southern Illinois seed source were planted in 1970 in a 32-year-old shortleaf pine plantation. Site index (base age 40) of the plantation is 21 (64 feet), which is above the average of 18 (61 feet) determined for shortleaf pine in southern Illinois (Gilmore 1979). The pine was planted at a 1.8 x 1.8 m spacing and the yellow-poplar was planted at 1.8 x 2.4 m spacing (2200 trees/ha) between the rows of pine. Basal area and density of the pine in 1970 averaged 48 m^2 and 1480 trees per ha, respectively.

Four years after the yellow-poplar seedlings were planted, the pine in various 0.20 ha plots were either (1) clear cut, (2) cut to 13.8 m^2/ha of basal area, (3) cut to 23 m^2/ha of basal area, or (4) no pine were cut (control, 43.7 m^2/ha of basal area). The treatments were replicated three times in a randomized complete block design. The stemwood of the cut trees was removed in a pulpwood operation.

Survival counts of the yellow-poplar were made at the end of 1970, 1972, and 1982 and diameters and heights of the yellow-poplar and pine were measured in 1982. All measurements were in the interior 0.04 ha of each 0.20 ha plot.

RESULTS & DISCUSSION

Survival of the planted yellow-poplar seedlings following the first and third growing seasons averaged 83 and 73 percent respectively. Survival percentage continued to decrease as the plantation became older, averaging 61 percent in 1982 (Table 1). These 1200 plus trees per ha presently on the area should be adequate to insure 500 crop trees per ha at rotation age. There was no significant difference in the survival of the planted seedlings during any of the three measurement periods that could be attributed to treatment or plot location.

The low survival during the first growing season can partly be attributed to low soil moisture during June, July and August of that year. Total precipitation from June 5 to September 1 of 1970 was only 9 cm, which was considerably below the average for that period. We have no information that enables us to speculate on the reason(s) for the additional 22 percent mortality after the first growing season.

Nineteen percent of the yellow-poplar in the plantation had two stems per tree. An additional five percent had three or more stems per tree. But the number of multiple stems per tree was not correlated (α = .05) with treatment or plot location. However, Gilmore _et al._ (1968) found that the occurrence of multiple stems was highests in shorter trees on the poorest sites where seedlings were subjected to extreme droughts. They reported that on these sites yellow-poplar seedlings had recurrent stem dieback. These results and the fact that there was no relationship

in the present study between the number of trees with multiple stems (associated with dieback) and treatment or plot location indicate that the plots were relatively uniform in the present study.

The largest average diameter of the yellow-poplar appeared to occur in the plots where pine had been thinned to 23 m^2 of basal area (Table 1). However no significant difference between treatments or replications was exhibited. Tree diameter is a reflection of stand density and it may be assumed that as the yellow-poplar become older and occupies more space in the stand a significant increase in correlation will be found between diameter of these trees and basal area of the residual pine.

Table 1. -- Height, d.b.h., and density of yellow-poplar and shortleaf pine in 1982 according to degree of pine thinning.[1/]

Treatment of Pine Overstory	Yellow-Poplar						Pine			
	Trees/ ha	Survival %	d.b.h.(cm) Av.	d.b.h.(cm) Largest	Height(m) Av.	Height(m) Tallest	Trees/ ha	B. A. m^2/ha	d.b.h. cm	Ht. m
Not thinned	1400	65a	3.8a	8.4	5.3ac	7.3	798	40.4	25a	20.7a
23.0 m^2BA	1375	62a	5.1a	15.2	6.5a	9.4	511	24.3	24a	20.7a
13.8 m^2BA	1358	61a	4.3a	10.9	4.5bc	8.2	296	18.1	26b	20.7a
0 m^2BA	1242	56a	3.3a	8.9	3.7b	7.0	---	---	--	---

[1/]Within each treatment, treatment values followed by the same letter are not significantly different(α = .05).

The best height growth of yellow-poplar was 6.5 m in the plots thinned to 23 m^2 and the poorest growth was 3.7 feet in the clear cut plots (Table 1). The tallest yellow-poplar in the stand (9.5 m) was in a plot thinned to 23 m^2 whereas the tallest tree in a clear cut plot was 7 m. In the earlier study by Young *et al.* (1969) the best growth occured in those plots that had been clear cut with both survival and growth declining as the pine density increased. The poor growth in the clear cut plots in the present study can be partly explained by the fact that honeysuckle (*Lonicera japonica*)

was extremely dense in these plots after the pine was cut. This vine undoubtly is competing for moisture and nutrients and there is also the possibility that an allelopathic effect is affecting tree growth. It is assumed that when the canopy closes, the honeysuckle will be shaded-out and the growth rate of yellow-poplar will accelerate. We can not explain why the best height growth occured on the 23 m^2 plots.

The number of pine trees in the non-thinned plots averaged 798 trees per ha in 1982 (Table 1). This is almost a fifty percent reduction in the number of pine in twelve years. A large percentage of this mortality can be attributed to Fomes annosus, a root rot fungus that is prevelant in shortleaf pine stands in the area that have been thinned or mechanically injured. The pine in 1982 were uniform in height but the largest diameter pines were found where the pine stand was the most open (13.8 m^2 of basal area). A large percentage of the smaller diameter trees had been removed in the thinning operation which resulted in the average size tree being larger.

Results from this study demonstrates that planted yellow-poplar will survive in the understory of a pine stand. We found that it is not necessary to remove the pine overstory imediately after underplanting yellow-poplar but can be delayed at least four years without apparent harm to the seedlings. After four years growth the seedlings are about 0.9 to 1.5 m tall and will recover if bent or broken during a logging operation. Trees taller than this are apt to be seriously injured in such an operation.

We do not recommend planting yellow-poplar seedlings in a partially thinned pine stand unless the pine is to be removed in less than five years. The possible injury to pole size yellow-poplar during a logging operation and/or loss of some if not most of the residual pine trees in a thinned stand from Fomes annosus renders the practice of planting this species in a partly cut pine stand questionable.

This study as other studies (Gilmore, et al., 1982) suggest that pine can improve the quality of a degraded site so that a subsequent species such as yellow-poplar can make acceptable growth when planted on the site.

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