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TREATMENTS NEEDED TO REGENERATE YELLOW-POPLAR IN NEW JERSEY AND MARYLAND

Abstract. In 17 areas, mostly in the Coastal Plain and Piedmont sections of New Jersey and Maryland, treatments were made to favor the establishment and growth of yellow-poplar reproduction. Results emphasize the importance of fairly large overstory openings (preferably 1 acre or more) and of reductions in understories by mistblowing, burning, or disking, but show that seedbed preparation is needed only in areas borderline because of deep litter, scant seed supply, or dense herbaceous growth.

Yellow-poplar is a highly valued tree that is well adapted to many sites on the better soils of the Piedmont and Coastal Plain of the Northeast. However, harvest cutting in stands containing yellow-poplar often fails to provide good stocking of poplar in the succeeding stands. Practicing foresters have long needed more information about how to regenerate this species, both in reproducing relatively pure stands and in converting to poplar those mixed stands that have only a scattered poplar seed source.

Observations by State and Station foresters in the Coastal Plain and Piedmont of the Northeast have indicated that three steps might be necessary to obtain establishment and dominance of adequate amounts of yellow-poplar reproduction. These steps are:

1. Creation of fairly large holes—1 acre or more—in the overstory.
2. Elimination or at least top-killing of the dense woody understories common on many sites.
3. Improvement of seedbeds by burning, disking, or other disturbance.

There is some question about the need for all three of these steps. For example, is seedbed treatment essential where understories are sparse or have been much reduced by the use of herbicides?

To obtain further information about the requirements for regenerating this species, the Northeastern Forest Experiment Station recently conducted a study in cooperation with the Maryland Department of Forests and Parks, the New Jersey Department of Conservation and Economic Development, several private landowners, and the U. S. Department of Defense. The first experimental area was treated in time for reproduction to become established in 1963; a second was treated for 1964 regeneration; and 15 more areas were treated for 1965 regeneration. This report describes the 1965 results in all 17 areas.[1]

Study Methods and Conditions

Our study emphasized seedbed treatment rather than the conditioning of the overstory because open conditions are generally recognized as necessary, and some studies on effective size of holes in overstory stands had already been made by Smith,[2] Roach (1962), and Minckler and Woerheide (1965). Holes in the overstory of about 1 acre, created either by injecting overstory trees with herbicide or by combining a harvest cutting with herbicide injection, were adopted as standard situations for testing the seedbed treatments. Also standard on most of the experimental areas was a mistblower application of 2,4,5-T herbicide to kill back the woody understories.

The injector and mistblower treatments were always made the year before the reproduction was to start. The mistblowing, of necessity, was done during the preceding growing season; the injecting was done during the preceding fall or winter. In the latter operation, about 1.5 milliliters of 2,4,5-T ester in fuel oil (80 pounds aehg) were applied per 3-inch cut in complete frills. In the mistblowing, a less-concentrated mixture (40 pounds aehg) of 2,4,5-T in oil was applied with a back-pack outfit at rates varying from 2 to 7 gallons per acre according to the density of the brush.

Original vegetation.—The 17 experimental areas were all in the Coastal Plain and Piedmont sections of New Jersey and Maryland, except one area in the New Jersey Highlands.

[1] The author thanks Adna Bond, Clifton Dennis, Charles Keeley, James Klunk, John Michel, and Chester Sewell of the Maryland Department of Forests and Parks; Gordon Bamford, Charles Holsworth, Otto Kunkel, George Moorhead, and Santiago Porcella of the New Jersey Bureau of Forestry; and James Opdycke of the U. S. Department of Defense for their help in selecting sites, surveying areas, making treatments, and tallying reproduction. The establishment work was done under the direction of R. H. Fenton of the Northeastern Forest Experiment Station.

[2] Smith, Henry Wilds, Jr. ESTABLISHMENT OF YELLOW-POPLAR (LIRIODENDRON TULIPIFERA L.) IN CANOPY OPENINGS. Unpublished Ph.D. thesis, Yale University, 1963.

The overstory stands ranged from predominantly poplar to mixtures in which poplar was a minor component, but all had at least enough poplar to serve as a seed source. The associated species at one site or another included various oaks, sweetgum, beech, red and sugar maples, ash, sweet birch, hickory, basswood, and elm. Many of the stands also had a second story composed largely of smaller members of the tolerant and intermediate species in the overstory.

Beneath or blending into the second-story trees were various kinds of shrubs varying in densities from thickets to scattered single stems. The most common species were dogwood, spicebush, viburnums, and sweet pepperbush. Less frequently encountered were high-bush blueberry, mountain-laurel, and witch-hazel.

Many of the sites had little herbaceous ground cover before the overstory was disturbed. However, in a few places a luxuriant growth of May-apple, cohosh, asters, ferns, and similar plants was found.

Seedbed treatments.—The seedbed treatments were scarification (mostly by hand), burning, and no ground disturbance. With a few exceptions, as noted below, scarification and burning were each applied to 10 randomly located 2-milacre quadrats in each study area. The areas, originally planned to be 1 acre each, departed from this standard size in some instances; the range was 0.67 to 1.5 acres.

Scarification was done in most areas with fire rakes in October or November. In one area (Woodstown B) no scarification was done, and in another (Elkton) a bulldozer was used to treat lines about 6 feet wide.

The burns were all light because of low fuel volumes, and sometimes not all the unincorporated organic material was consumed. No burning was done on two areas (Elkton and Mutual). On one other area (Sergeantsville), two plots of 600 square feet each were burned instead of the usual 10 quadrats; and on another (Woodstown B) one plot of 1/3 acre was treated. Most of the burns were made in October or early November, but one was delayed until January and another until April.

To determine the relative importance of seed stored in the forest floor and seed of the current crop, special quadrats were installed at two sites to exclude fresh seed. These quadrats were burned in the fall and then covered with pinned-down window screening before the poplar seeds were shed. Two strips, each 28 inches wide and 25 feet long, were covered at one site (Woodstown B); at the other (Leonardo A), only one 2-milacre quadrat was covered. The screening was removed the following May.

Seedfall and reproduction tallies.—In each area four seed traps were installed to provide estimates of the amount of yellow-poplar seed distributed during the fall and winter when the seedbed treatments were made. The collected seeds were cut to determine the proportions that were sound.

Subsequent reproduction of yellow-poplar was tallied in the fall of 1965. On areas where scarification and burning treatments had each been applied to ten 2-milacre quadrats, the sampling included 40 quadrats as follows: all 20 treated quadrats, and 20 additional quadrats of the same size randomly located on undisturbed seedbeds. On the four areas where the treatment pattern was different or one of the treatments had been omitted, the sampling for reproduction was modified to fit the situation.

These reproduction tallies on the 15 areas that had gone through only one growing season in the fall of 1965 are the basis for most of the following discussion of results. Data from the two older areas are noted briefly where they supplement the 1-year data.

Results

Seedling stocking.—The abundance and distribution of yellow-poplar seedlings in the fall of the first year after the areas were treated seemed to be determined mainly by seed supply, light intensity, and seedbed treatment.

According to the seed-trap records, seedfall from the 1964 crop varied from about 21,000 to 1,626,000 sound seeds per acre. The seed averaged 17 percent sound, varying among sites from 7 to 24 percent sound.

However, the 1964 seed seemed to have little effect on seedling abundance the next year; most of the reproduction that started in 1965 apparently came from seed stored in the forest floor. This was indicated by results on the two areas where sample portions of burned seedbed had been screened to exclude fresh seed. Here the numbers of new seedlings per acre in the fall of 1965 were about the same as in similar unscreened seedbeds, as shown below:

Area	*Not screened*	*Screened*
Leonardo A	Average—17,250 Maximum—32,000	31,000 (1 quadrat)
Woodstown B	Average—37,600 Maximum—79,000	48,540; 97,080 (2 strips)

The minor role played by the 1964 seed was also demonstrated on another area (Shiloh) where the quadrats were not burned until April 1965. Although most or all of the 1964 seed was then down and presumably destroyed by the burning, an abundance of seedlings (64,950 per acre) was present the following September.

Table 1.—*Effect of seedbed treatments on the amount of yellow-poplar reproduction and stocking of quadrats at the end of the first growing season*[1]

Area	Seedlings per acre			Quadrats stocked with yellow-poplar[2]		
	Burned seedbeds	Scarified seedbeds	Controls	Burned seedbeds	Scarified seedbeds	Controls
	Number	*Number*	*Number*	*Percent*	*Percent*	*Percent*
Pottersville	62,450	72,650	28,225	100	100	100
Hopewell	82,850	128,550	14,900	100	100	100
Warrenville	27,450	36,150	9,525	100	100	95
Watchung	91,500	66,800	35,600	100	100	100
Woodstown A[3]	53,450	70,750	9,275	100	100	95
Woodstown B[3]	37,600	—	1,467	100	—	60
Shiloh	64,950	88,300	3,125	100	100	80
Leonardo A	17,250	23,250	3,850	100	100	80
Leonardo B	62,100	81,050	30,250	100	100	100
Woodlawn	62,150	55,750	6,875	100	100	70
Dayton	51,200	43,650	6,125	100	100	95
Cedarville	117,450	103,350	11,250	100	100	95
Mutual	—	17,100	2,450	—	100	85
Preston	15,850	17,000	600	100	100	50
	(16,350)	(17,850)	(1,325)	(100)	(100)	(60)
Harmony	4,550	2,150	325	80	100	40

[1] Practically all reproduction is seedlings of 1965 origin. Data for the Preston area are separated because older reproduction was present in sufficient amounts to affect results. The first Preston values are for 1965 reproduction; those in parentheses include 1965 and older reproduction.

[2] 2-milacre quadrats, except in Woodstown B area where 1-milacre quadrats were used.

[3] Area A was treated with both injecting and mistblowing; B had injecting but no mistblowing.

McCarthy (1933) mentioned an instance of dense stocking to yellow-poplar seedlings the first summer after a spring fire in Maryland, and New Jersey foresters have observed similar reproduction after some spring wildfires. These data and observations indicate that much, if not all, of the reproduction after burning comes from seed already in the forest floor. Reproduction on scarified or undisturbed seedbeds may also be mostly from stored seed, as Clark and Boyce (1964) suggest.

In our study, variable amounts of seed stored in the forest floor are believed to have been the chief factor responsible for the wide range in stocking density that was found on the disturbed seedbeds. This range was from 2,150 to more than 100,000 seedlings per acre (table 1). There was no discernible correlation between number of seedlings per acre and seedfall from the 1964 crop.

Light intensities approaching those of full sunlight appear essential for obtaining adequate establishment and survival of yellow-poplar reproduction. In the oldest area of our study, treated in 1962, some quadrats on partially shaded undisturbed seedbeds were stocked in 1963 but by 1965 had no surviving seedlings, while unshaded quadrats on similar seedbeds still had 1,167 seedlings per acre (and were 50-percent stocked). Even first-year reproduction may be reduced by shade in some places: in the Woodstown B area, which was not mistblown, there were only 1,467 seedlings per acre on undisturbed seedbeds, as compared to 9,275 seedlings per acre on similar seedbeds in the adjoining mistblown A area (table 1).

Seedbed treatments increased the amount of reproduction (table 1), but the magnitude of the increase varied greatly—from 2 to 28 times the number of seedlings found on undisturbed seedbeds. There was no consistent difference between those areas burned and those scarified in the number of seedlings each produced.

Even though seedbed treatments greatly favor seedling establishment, they seem unnecessary on most sites. In only 3 of the 15 areas treated in 1964 was the amount of reproduction on undisturbed seedbeds less than 2,000 seedlings per acre and stocking by quadrats less than 70 percent (table 1). In these three areas shade was a confounding factor. Mistblowing had not been used in two (Woodstown B and Preston), and the injector treatment had had little effect during 1965 in the third (Harmony).

However, seedbed treatments may be necessary on the drier sites where relatively thick litters of beech or oak leaves accumulate. In the Shiloh area four undisturbed quadrats with such a litter were unstocked, while two disturbed quadrats had 27,000 seedlings per acre.

Seedling height.—Seedling height at the end of the first growing season was apparently affected by the amount of shade and competition, by available soil moisture, and by the presence of advance reproduction—but not usually by seedbed treatment. Height was measured only for the tallest seedling per quadrat, and the resulting data showed little difference among seedbed treatments. Only in the Woodstown B area was there an appreciable difference—0.41 foot average height on burned quadrats versus 0.14 foot on undisturbed quadrats—and this appeared to be due to the greater shade on the latter (understory not reduced here because no mistblowing done). Even when the height of fewer, more dominant seedlings (100 per acre) was considered, there was no consistent and important difference among seedbed treatments. In only two areas did the average height of these seedlings on disturbed seedbeds exceed by 0.25 foot the height of those on undisturbed seedbeds. In contrast, the differences between study areas were much greater: average heights of the tallest 100 seedlings per acre varied from about 1 foot to 0.2 foot, probably because of differing amounts of light and soil moisture.

Only in the Preston area was enough advance reproduction present to appreciably affect seedling height averages. There, when advance reproduction was included, the average height of the tallest 100 seedlings per acre varied by seedbed condition between 1.5 and 1.8 feet; when advance growth was excluded, the range was 0.2 to 0.3 foot.

The 2-year-old Elkton site, which initially had only a sparse herbaceous ground cover, was similar to the 1-year-old areas in that seedling height was little affected by seedbed treatment. For the tallest 100 seedlings per acre, the average heights were 1.9 and 1.6 feet for scarified and untreated seedbeds, respectively.

Although seedbed treatments do not generally seem to have much effect on seedling height growth, the 3-year-old Sergeantsville site demonstrated that this may not hold true where dense herbacous ground cover is present. This site had a cover of cohosh, May-apple, ferns, and other woodland herbs. Here, excluding data from partially shaded quadrats, the treated seedbeds at the end of the third growing season not only had 3,300 more seedlings per acre and higher quadrat stocking (100 percent) than untreated ones; they also had produced taller seedlings. Average heights of the tallest 100 seedlings per acre for the three treatments were: scarified —2.2 feet; burned—1.8 feet; and untreated—1.4 feet.

The dense herbaceous ground cover apparently accounted for these differences by exerting a greater adverse effect where it remained intact than where it had been set back by the seedbed treatments.

Since the upper canopies of 50-year-old stands need contain no more than 100 to 150 stems per acre, the number, stocking, and growth of the poplar seedlings on the untreated seedbeds in our study areas seem generally to be adequate. When overstories and understories have been sufficiently reduced by herbicides and cutting and a good seed source is (or was) present, the larger catches of seedlings resulting from seedbed treatments will often be superfluous. However, where seed supplies are scanty, seedbed treatments would increase the catch from whatever seed was available, and often would be necessary to obtain adequate reproduction.

Recommendations

For obtaining adequate amounts and growth of yellow-poplar reproduction in the Coastal Plain and Piedmont of the Northeast, the following steps seem essential:

- Create holes 1 acre or larger in the overstory by harvest cutting or by injecting herbicide. In smaller holes, even of 1/4 acre, it is possible to obtain some yellow-poplars, but these holes have a high proportion of shaded edges, which favor more tolerant species. Usually make holes circular or square; don't use narrow strips that receive appreciable shade from the adjoining stands. If preservation of a high-forest appearance is not an important consideration, the size of the clearcut or injected area need not be limited—provided the whole area has been receiving fair supplies of yellow-poplar seed. Don't leave scattered residual trees in the hole: they develop epicormic branches, become low-quality stems, and interfere with yellow-poplar reproduction.

- Kill back or eliminate understories, usually before making overstory treatments. Mistblowing often suffices; disking or burning are alternatives, especially where drift of the herbicide to cultivated crops would be a hazard. Burning or disking will not usually eliminate as many stems as mistblowing. Inject stems not killed by mistblowing, disking, or burning. If Japanese honeysuckle is present, take special measures to eliminate it.
- Use disking or burning for seedbed preparation primarily on the somewhat dry borderline sites where oak or beech litter is deep enough to seriously reduce establishment of yellow-poplar seedlings. Seedbed treatment also seems advisable on sites having a low seed supply in the forest floor, especially if these are covered with dense herbaceous growth. However, herbaceous cover thus far has not severely limited yellow-poplar establishment, survival, and growth in any of the 17 areas in this study.

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