Thinning BALSAM FIR THICKETS with Soil Sterilants

by Arthur C. Hart

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About the author . . .

ARTHUR C. HART *is a Research Forester at the Northeastern Forest Experiment Station's Bangor Research Center at Brewer, Maine. After receiving his Bachelor's degree in forestry from the University of Connecticut in 1936 and his Master's from Yale School of Forestry in 1938, he spent 3 years in research work for the Northeastern Forest Experiment Station at Alfred, Maine, and on the Gale River Experimental Forest at Bethlehem, N. H. He left Federal service in 1941 to become forest manager for the Great Mountain Forest at Norfolk, Conn., leaving that position in 1943 to become senior forester with the Exploration Division of the Rubber Development Corporation in Brazil and later with the Corps of Engineers at the American Cinchona Plantation in Costa Rica. Hart returned to the Northeastern Forest Experiment Station in 1946 and has since been employed in forest research in the spruce-fir type at The Gale River Forest and for the past 12 years at the Bangor Research Center.*

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The Problem of Thickets

Under certain conditions that we do not yet fully understand, balsam fir has a tendency to form dense thickets that cause stagnation of growth. This condition is common throughout the spruce-fir region, and it presents the landowner with one of his most perplexing management problems. A typical thicket averaging 15 feet tall may contain 5,000 to 10,000 stems per acre (fig. 1). Small areas may have densities up to 30,000 stems per acre.

Natural thinning will eventually reduce this excessive number of stems. But this process may take 30 to 60 years; and by the time the trees reach merchantable size under these conditions, many are overmature and weakened by butt rot. The annual rate of net growth and the financial return from these areas are accordingly much less than for normal stands. Thus fir thickets may represent a sizable financial loss to the forest owner.

Figure 1. — *Growth is very poor in balsam fir thickets. This typical fir thicket in central Maine is about 40 years old.*

If effective and inexpensive thinning techniques could be developed, the time required for fir thickets to reach operable size would be reduced, thereby substantially increasing yields and income. However, the use of hand tools (axes, machetes, saws, etc.) in thinning fir thickets is very expensive. Other less expensive methods are needed. One possibility is to create holes in the thickets by means of tree-killing chemicals so that trees around the margin of the holes are at least partially released from competition.

In the summer of 1955 the Bangor Research Center of the Northeastern Forest Experiment Station began an exploratory study in the use of soil sterilants as a means of creating such holes in fir thickets. This is a progress report on that study.

The Area

The area selected for this study is on the Penobscot Experimental Forest near Bangor, Maine. The stand was a dense 35-year-old balsam fir thicket averaging about 16 feet tall and having between 8,000 and 9,000 stems per acre in 1955. Although trees ranged from a few feet tall to pole-size, about 90 percent were between 0.5 and 2.5 inches in diameter at breast height. The thicket had developed under a scattered overstory of large white pine, spruce, and an occasional hemlock.

The soil here is a shallow, poorly drained, moderately acid silt loam of lacustrine origin having a hardpan at about 12 inches. Tree roots are concentrated in the 2-inch humus layer and in the upper 6 inches of mineral soil.

Procedures

The study involved 24 treatments — combinations of 3 soil-sterilant chemical formulations, 2 dosages, 2 positions, and 2 spot sizes. The treatment unit was a spot. Each treatment was replicated on 4 spots.

A plot 2 chains wide and 3 chains long was laid out in the selected area. A grid of lines 15 feet apart was established within this plot. At the intersections of these lines, spots were marked and numbered for identification and subsequent treatment with the soil sterilants under test. All dead trees within 5 feet of each spot were removed. Treatments were assigned to these spots at random.

Three chemical formulations were tested: Telvar W, containing 80 percent 3-(p-chlorophenyl)-1, 1-dimethylurea and 20 percent inert ingredients; arsenic trioxide, commonly known as white arsenic; and Chlorea, a preparation containing 40 percent sodium

chlorate, 57 percent sodium metaborate, and 1 percent 3-(p-chlorophenyl)-1, l-dimethylurea.[1]

Two concentrations or dosages of each chemical were used. These represented the approximate upper and lower limits of the generally recommended range of dosages prescribed by the manufacturers for killing woody perennial plants. They were as follows:

Telvar W	— 40 and 80 pounds per acre
Arsenic trioxide	— 800 and 1,200 pounds per acre
Chlorea	— 900 and 1,300 pounds per acre

It was assumed that openings 7 feet in diameter would be adequate in the thicket selected; so the dosage for this size area was calculated from the recommended per-acre dosage.

Each formulation and dosage was applied to spots of different size: circles 1 foot and 2 feet in diameter. The required amount of chemical was distributed as evenly as possible over each spot. All treatments were applied during the first week of July 1955.

Experience with other kinds of vegetation indicated that the buffering effect of humus might reduce the lethal effects of the chemicals to a considerable extent. For that reason each of the treatment variants described above was tested by applying the chemicals not only directly on the humus, but also on the mineral soil after humus had been removed with a mattock.

The area was first examined in September 1955, 70 days after treatment; later examinations were made in November 1956 and October 1957. During each of these examinations the d.b.h. and distance from the spot center were recorded for each new dead tree at each treatment spot. Supplementing the 1957 examination, numbers of dead and live trees within a 7-foot circle centered on each spot were recorded in February 1958. General observations were continued through 1960 to determine whether any further mortality or injury from the chemicals was occurring.

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[1] The cooperation of the following manufacturers in furnishing the chemicals is gratefully acknowledged:

E. I. duPont de Nemours & Co., Inc. — Telvar W
The American Smelting & Refining Co. — Arsenic trioxide
The Chipman Chemical Co. — Chlorea

Mention of these chemicals is not to be construed as an endorsement of them by the Forest Service or the U. S. Department of Agriculture.

Results

Although control spots were established to provide an estimate of natural mortality, we found it easy to distinguish chemically killed trees from the occasional trees that were dying from suppression or other natural causes. So we made no real use of the control spots. All data and conclusions presented below are based upon kills clearly attributable to the chemical treatments.

By September 1955, approximately 2 months after treatment, only a few trees had died. These were at spots treated with Chlorea. There were no dead trees at spots treated with Telvar W or arsenic trioxide.

By November 1956, the second fall after treatment, effects of the chemicals were clearly evident. All the chemicals had killed some trees, but Telvar W was the most effective, both in numbers of trees killed and average distance of killed trees from point of application. An average of 5.7 trees were killed at spots treated with Telvar W, compared to 1.6 and 2.0 trees respectively at spots treated with Chlorea and arsenic trioxide. Average distances of killed trees from the spot centers were 2.31 feet for Telvar W, 0.97 feet for Chlorea, and 1.10 feet for arsenic trioxide.

Some apparent trends toward relationships between kills and the other experimental variables were noted: for Chlorea, greater kills with the higher dosage, and kills to a greater distance with humus treatment than with mineral-soil application; for Telvar W, kills to a greater distance with 2-foot than with 1-foot application spots. However, none of these differences was statistically significant.

By the fall of 1957, the third fall after treatment, more trees had succumbed. Telvar W still was the most effective of the three formulations.[2] It had killed an average of 9.2 trees per spot, compared to 2.0 and 2.2 trees respectively for spots treated with Chlorea and arsenic trioxide. Some of these trees were outside the

[2] Analysis of variance, followed by "t" tests, showed the differences between Telvar W and both Chlorea and arsenic trioxide to be significant at the 1-percent level, with respect both to percentage of trees killed within the 7-foot circles, and to average distances of killed trees from centers of application.

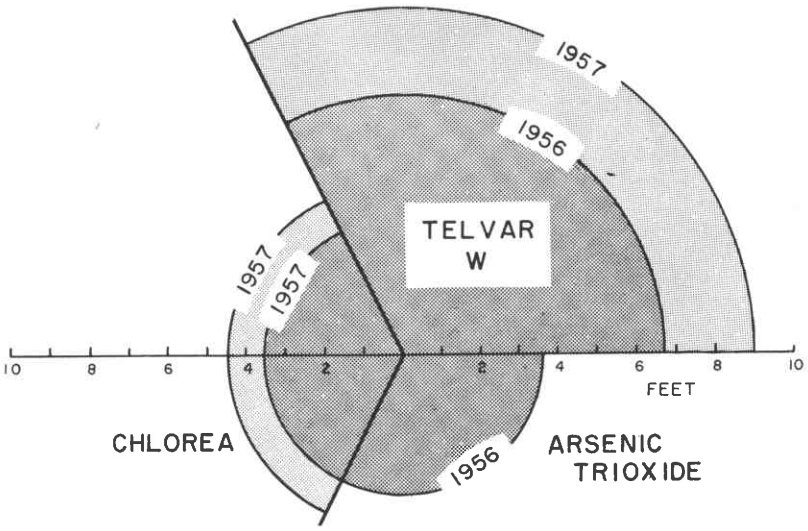

Figure 2. — *Maximum distances to killed trees, by formulations, two and three growing seasons after treatment.*

7-foot circles. Considering only the trees within the circles, Telvar W had killed about 2½ times as many trees as the other formulations. Comparative proportions of kill were as follows: Telvar W — 78 percent, Chlorea — 28 percent, and arsenic trioxide — 31 percent.

The average distance of killed trees from spot centers was 3.03 feet with Telvar W, 1.25 feet with Chlorea, and 1.15 feet with arsenic trioxide. Telvar W killed to a maximum distance of 9 feet from the center of application. The maximum for Chlorea was 4.5 feet, and for arsenic trioxide 3.6 feet (fig. 2).

Three years were required for Telvar W to develop its full effect. Only 60 percent of its total 3-year kill had occurred after 2 years. With Chlorea, 80 percent of the 3-year kill had materialized in 2 years, and with arsenic trioxide 90 percent.

None of the chemicals caused appreciable mortality after 3 years. Trees around the treated spots that had not succumbed by that time seemed to have suffered no ill effects from the chemicals; from general observation, they appeared as healthy as other trees in the stand.

Discussion

None of the chemical formulations was completely effective in creating the desired 7-foot openings in the thicket. The most effective one, Telvar W, which killed an average of 78 percent of the trees within 7-foot circles centered on the treated spots, can be considered only a partial success. The 22 percent mean survival within circles represented an average of 2.5 trees per circle. Since tree densities outside the 7-foot circles were only slightly reduced from original thicket conditions, Telvar W applied to a thicket in the same way as in our test would not have accomplished an adequate opening of the stand.

The results do indicate, however, that spot or localized treatments with soil sterilants hold some promise as a means for opening holes in young fir thickets and releasing them from stagnation. To develop an effective and practicable method for doing this, further research will be required. This should involve trials of other chemical formulations, and other procedures for their application.

Summary

In 1955 a study was undertaken on the Penobscot Experimental Forest to test the effects of three soil-sterilant chemical formulations when applied to small spots in a balsam fir thicket. The objective was to create holes in the stand, thereby accomplishing a crude thinning. Data collected for 3 years after treatment showed that:

- Telvar W was more than twice as effective as either Chlorea or arsenic trioxide.
- Telvar W killed trees to a maximum distance of 9 feet from the center of application.
- Considering only the trees within 7-foot circles centered on the application spots, kills with Telvar W averaged 78 percent.
- Among other variables in the experiment (40 pounds versus 80 pounds per acre of Telvar W, application on undisturbed

humus versus application on mineral soil, and application to spots of 1 foot versus 2 feet in diameter) differences in kills were not significant.

- The kills accomplished with Telvar W were only a partial success in opening up the stand. Further research with other chemicals and other application procedures will be required to develop an effective and practicable method for thinning fir thickets this way.

ACKNOWLEDGMENT

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