Minnesota Forestry Research Notes
No. 233
October 15, 1971

SAWFLY DEFOLIATION AFFECTS SHOOT GROWTH OF WHITE SPRUCE --A PRELIMINARY REPORT--[1]

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Introduction

The yellow-headed spruce sawfly (Pikonema alaskensis Roh.) has been reported as a defoliator of most species of spruce (Picea) in the United States and Canada. Recent Minnesota studies (Pauley and Mohn 1971) have shown that white spruce (P. glauca Moench) is more heavily defoliated than black spruce (P. mariana Mill.). Reports of significant defoliation and damage in forests and plantations are almost wholly restricted to small white spruce.

The life history of the sawfly is well known (Nash 1939). It overwinters as a prepupal larve in a cocoon and pupates in the spring. The adult sawflies cut their way out of the cocoon in late May or early June soon after the buds of white spruce expand. Eggs are deposited in the new needles and the small yellow-green larvae chew their way out of the eggs in 5-12 days. They feed on new needles and move to older foliage only after the new foliage is nearly all eaten. However, in Minnesota, it was found that many of the new needles on the terminal shoot of the tree and a few on the terminal shoot of the branches would often be left. When the larvae are about 2-2.5 cm. long they drop to the ground and dig into the mineral soil to spin a cocoon and overwinter.

Although the yellow-headed spruce sawfly is a very common and conspicuous defoliator, reports of percentage of defoliation or counts of dead trees in defoliated stands are the only damage data available.

The purpose of this study was to document the effects of defoliation by the yellow-headed spruce sawfly on the shoot growth and survival of small white spruce trees. This report covers only the initial studies in Koochiching County in plantations established by the Boise Cascade Corporation

Methods

During July, August and September of 1967, 371 white spruce trees, 5-8 feet tall,

[1] The assistance of the Boise Cascade Corporation and Mr. John Beck of their staff is gratefully acknowledged. The assistance and advice of Mr. Gerald Beach of the Minnesota Division of Plant Industry is also greatly appreciated.

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Published by the College of Forestry, University of Minnesota, St. Paul, Minnesota 55101

were examined after defoliation by the sawfly for 1 or more years from 1965 to 1967. Forty trees showing no sign of defoliation were also marked. Trees with other damage or signs of earlier defoliation were not used. Each tree was numbered and the percentage of defoliation of new and old needles was estimated separately. Needle stubs and twig discoloration aided in determining the year that defoliation occurred. The trees were re-examined in the fall of 1969 at which time 1968 and 1969 defoliation was recorded. Trees with 1969 defoliation were not used in the study since the effects of defoliation on shoot elongation would not be fully expressed until the following year in this type of conifer (Kulman 1971). Thirty or more trees were selected in most defoliation categories in 1967. However, variations in subsequent defoliation and other damage made it necessary to drop many trees from the study in 1969. Categories with 6 or more trees still available at the end of the study are given in the Table.

Measurements of the terminal shoot growth of the trees were made to the nearest 0.5 inch for shoots over 4 inches and to the nearest 0.25 inch for shoots under 4 inches. Similar measurements were made on branches that were 6 or more years old in the middle 1/3 of the crown.

Results and Discussion

As shown by the averages in the Table, the predefoliation tree heights and shoot growth were similar between control and the various levels of defoliation. The lightest defoliation category (B) shows a reduction in the length of both the tree and branch terminals in the year following defoliation (1968) and nearly complete recovery in the second year after defoliation (1969) for tree terminals, but a somewhat poorer recovery for branch terminals. The same pattern is present for the next heaviest defoliation (C), but recovery of shoot growth in the second year after defoliation is much poorer, being about 1/2 that of the nondefoliated trees (A). In the heaviest defoliation category (D), needles were consumed in both 1967 and 1968. The tree and branch terminal shoot growth was reduced to 30% and 19%, respectively, of the predefoliation shoot growth. The last defoliation pattern (E) is similar to pattern C except that the recovery was much slower.

The better recovery in growth in the tree terminals over the branch terminals is probably related to some extent to the larger number of new needles that were left by the sawfly on the tree terminals than on the branch terminals.

The Table indicated rather clearly that defoliation reduces shoot growth and that recovery is often incomplete after two additional growing seasons. However, there was a very large variation between branches on the same tree and between trees in the same defoliation grouping. These data and data from planned new studies in other Minnesota locations will be analyzed in greater detail in a subsequent paper.

It is generally accepted that shoot elongation in northern conifers is largely dependent on photosynthate stored during the previous year (Kulman 1971). The shoot growth for 1967 (1966 for defoliation pattern E), the year that defoliation first occurred, showed a small, but consistant, reduction in shoot length as compared to the previous years or the nondefoliated trees (A). Although inconclusive at this stage, these data indicate that there is a contribution by new needles to current shoot elongation--probably photosynthate and/or growth regulators.

In the first year after heavy defoliation, the new shoots were very short and had closely spaced short yellow-green needles. On many of these trees the subsequent shoot elongation, needle size and spacing remained abnormally small for 1 and occasionally 2 additional years. However, there was always a progression in size and greenness of needles from year to year.

Tree mortality from sawfly defoliation was not observed in these studies. Many trees that were almost totally defoliated were tagged in 1967. In 1969 all were still alive, although they had many dead branches and small compacted groups of yellow-green needles. However, some of the tree terminals had normal needles and shoots up to 25% of the predefoliation shoot growth. All of the small dead white spruce plantation trees encountered in Koochiching County during the study were apparently killed by a mound building ant, Formica ulkei Emery.

Most evergreen conifers die after one complete defoliation that includes all of the new foliage (Kulman 1971). The remarkable survival of white spruce in this study with almost complete defoliation suggests that white spruce is one of the more defoliation tolerant conifers. However, several dead trees were observed elsewhere in Minnesota that apparently died after defoliation. Therefore, future studies should include soil and precipitation data, and heavier defoliation.

Table

Effect of Four Different Degrees of Defoliation by the Yellow-headed Spruce Sawfly in Mid-July on the Shoot Growth of White Spruce

Year of Origin of Defoliated Needles and % Defoliation	Defoliation Year and Crown Area Affected	Average Length of Tree Terminal Shoot					Average Length of Branch Terminal Shoot (3 Branches per Tree)					1966 Avg. Tree Ht.	No. of Trees
		1965	1966	1967	1968	1969	1965	1966	1967	1968	1969		
		(inches)											
A. Control; No defoliation	None	10.5 ±2.4	10.2 ±1.9	12.4 ±3.4	12.5 ±2.7	16.2 ±3.0	5.6 ±1.2	5.8 ±1.3	5.7 ±1.2	5.1 ±1.4	5.3 ±1.3	48.9	12
B. 1967; 80-99%	1967; Top 1/2 or more	9.6 ±3.8	9.8 ±4.2	8.4 ±5.3	5.0 ±3.3	13.2 ±3.3	6.1 ±1.7	5.4 ±1.5	4.8 ±1.6	1.7 ±0.7	3.2 ±0.7	47.0	6
C. 1966,67; 90-99%	1967; Top 2/3 or more	9.7 ±2.8	9.2 ±4.7	8.7 ±3.5	3.5 ±1.8	7.9 ±6.4	5.4 ±1.4	4.7 ±1.5	3.4 ±1.6	1.5 ±0.8	2.2 ±1.5	54.4	14
D. 1966,67,68; 90-99%	1967,68; Top 2/3 or more	9.3 ±4.2	9.8 ±3.7	6.6 ±3.4	3.3 ±1.1	2.8 ±3.5	5.3 ±1.7	4.8 ±1.6	2.4 ±0.9	1.2 ±0.6	1.0 ±0.9	58.4	14
E. 1965,66; 80-99%	1966; Top 1/2 or more	10.9 ±2.4	7.2 ±3.4	2.8 ±2.2	1.7 ±1.2	5.2 ±4.1	4.8 ±1.4	4.0 ±1.2	1.5 ±1.9	1.2 ±0.6	1.5 ±1.1	55.5	6

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Published as Sci. Jour. Ser. Paper No. 7773 of the Unv. of Minn. Agr. Exp. Sta.