Zusammenfassung

Bei den Polyphenolen und den Tanninen der Benadelung wurden quantitative Unterschiede zwischen den Saatgut-Herkünften von Pinus silvestris, P. nigra und P. resinosa gefunden. Die Variationsmuster korrespondierten aber nicht mit geographischen oder klimatischen Faktoren. Die beobachtete Variation wird vielmehr auf die unterschiedliche Reaktion der Herkunft auf die Umweltbedingungen am Pflanzort zurückgeführt (Herkunft-Umwelt-Interaktion). Pinus resinosa zeigte eine geringere Variation als die beiden anderen Kiefernarten.

Bei allen Species fand sich zwischen den Populationen nur eine geringe Variation der chromatographischen Grundmuster. Die chemische Variation stand in keinem Zusammenhang mit der morphologischen Variation. Eine Ausnahme bildete nur eine Herkunft von P. nigra aus der Ägäis, deren Verhalten auf das Vorhandensein natürlicher Hybridisation zurückgeführt werden kann.

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Resistance of Eastern White Pine (Pinus strobus L.) Provenances to the White-Pine Weevil (Pissodes strobi Peck.)[1]

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Introduction

Observation of damage caused by the white pine weevil (Pissodes strobi PECK.) in existing provenance studies in the Northeastern States offered a potentially quick, easy method of locating eastern white pine (Pinus strobus L.) that are resistant to attacks by this important insect. If resistant sources were found in our plantings, and if they were adapted to other sites in the white pine region (Fig. *1*), it is probable that this species would again become an important component of the reforestation programs in the Northeastern States, the Lake States, and southeastern Canada.

This paper reports the results of a three-year study of weeviling in a planting that contains 27 provenances of eastern white pine. The planting is completely randomized in each of 24 blocks. The results show that the amount of leader damage varied from 71—100 percent among the different provenances after the 1970 attack period. There was no correlation between weevil damage and latitude of seed source or average tree vigor.

In most cases, previous studies of the influnce of seed source on weevil damage in estern white pine lacked replication and included only a few sources (PAULEY et *al.* 1955, WRIGHT and GABRIEL 1959, TREFTS 1960, and CONNOLA 1966). One exception was a study by SOLES and GERHOLD (1968), who placed 3-year-old white pine seedlings from 80 provenances in cages with a predetermined number of adult weevils. Weeviling of trees at this age inducated provenance differences at the 0.05 level of probability, but no extrapolations were made to larger trees. Another exception was a report on 10-year-old trees by FOWLER and HEIMBURGER (1969). Weevil damage was so slight on all

[1]) This publication reports research involving pesticides. It does not contain recommendations for their use nor does it imply that the uses discussed here have been registered. All uses of pesticides must be registered by appropriate State and/or Federal agencies before they can be recommended.

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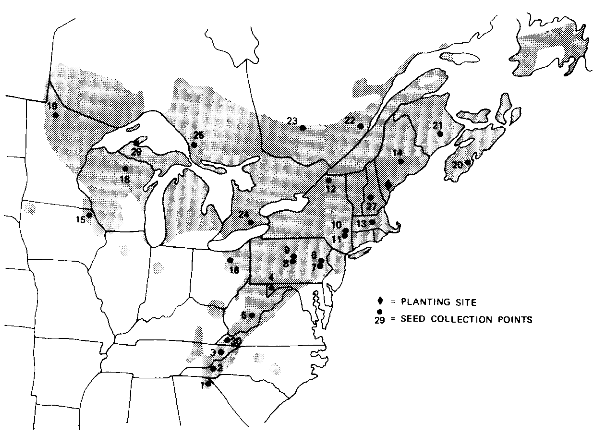

Figure 1. — Map showing the range of eastern white pine and the origin of the 27 seed sources included in planting 4—60 of the white pine provenance study.

provenances that no conclusions about source differences could be drawn. AREND (1961), BATZER (1962), and KING[3]) observed provenance differences in weevil attack on jack pine *(Pinus banksiana* LAMB.).

Objectives

The primary objective of this study was to determine the level and type of weevil attack by provenance. By observing individual trees over a period of several seasons, we were able to document the attack patterns and the resulting damage.

Materials and Methods

Four provenance plantings of white pine were made on land adjacent to the Massabesic Experimental Forest in southern Maine (70° 30' W, 43° 30' N). In this article, weevil damage in one of these plantings (4—60) is described.

Planting 4—60 consists of 24 blocks (replicates); each block contains one tree from each of 27 sources. Trees were completely randomized in each block. The planting includes a major portion of the botanical range of white pine *(Fig. 1)*.

Trees were hand-planted on 4 May 1960, on 10-foot-square areas that had been scalped by a tree-planting machine. The trees in the planting were sprayed each spring with a Lindane[4]) mixture to eliminate weevil feeding. After the annual spraying in the spring of 1967, this practice was discontinued; and weevils were permitted to enter the planting for the first time. Weevil damage was recorded in early August of 1968, 1969, and in 1970.

The trees in this planting were 12 years old from seed and averaged about 9 feet in height when they were first exposed to weevil attack in 1968. The weevil population in both 1968 and 1969 was extremely high. Because weevil damage to the terminal shoots made accurate determinations of height difficult, the measurements taken at age 10 were used for provenance heights.

The main stem terminal shoot of each tree was examined and the tree was then placed in one of three categories: (1) weeviled, leader dead; (2) adult weevil feeding, leaders not dead; and (3) no apparent adult weevil feeding.

Results

We were mildly surprised by the amount and uniformity of weevil damage that occurred in 1968 after only one attack season *(Table 1)*.

Terminal shoot mortality varied from a low of 33 percent (5 — West Virginia) to a high of 73 percent (25 — Northern Ontario). In the category of adult weevil feeding without leader mortality, a New York source (12) was lowest at 4 percent. In the third category, no apparent adult feeding, the Minnesota source (19) was lowest at 8 percent, and a Pennsylvania source (8) was highest at 46 percent.

In March 1969, approximately 1,000 laboratory-reared weevils were distributed throughout the planting, and in August 1969 all trees were again observed for weevil injury. In addition to the weevils that had been added to the stand in March, a large number overwintered successfully; and in 1969, there was again a very high population level.

The 1969 observations indicated additional weevil damage in every seed source. Because of the relatively small differences in weeviling between most provenances in 1968, there were some changes in ranking, although the actual differences were not significant.

The least weeviled source following the second attack season was the Pennsylvania source (8) with 57 percent dead leaders. The Virginia source (30) had 100 percent of the leaders killed by weeviling. Adult weevil feeding without leader mortality ranged up to 29 percent (21 — New Brunswick); and, in the category of no adult feeding, source 8 (Pennsylvania) was again the highest at 22 percent.

By the end of August 1970, the number of trees on which the leader had been killed at least once by weeviling was a very high proportion of the total in the planting. Source 8 (Pennsylvania), which was among the least weeviled sources in 1968 after one attack (37 percent), was the least weeviled after three attack seasons; but the percentage of killed leaders had risen to 71 percent. Seventy-three percent of the trees in source 25 (Northern Ontario), the most severely attacked provenance in 1968, had dead leaders due to weeviling. By the end of 1970, four sources were 100 percent weeviled with 12 sources sustaining over 90 percent leader mortality and only 3 sources receiving less than 80 percent.

Table 1. — White pine provenance planting showing percentage of leaders killed by weeviling. 1968—1970.

Provenance location	Seedlot no.	Weeviled, leader killed 1968	1969	1970	Height rank at age 10	Total no. stems
		(%)	(%)	(%)		
Georgia	1	50	76	82	17	21
North Carolina	2	62	92	96	25	25
Tennessee	3	58	82	84	14	22
Maryland	4	36	79	83	12	24
West Virginia	5	33	68	74	26	25
Pennsylvania	6	67	80	85	13	20
Pennsylvania	7	46	78	84	4	23
Pennsylvania	8	37	57	71	18	23
Pennsylvania	9	48	70	82	10	23
New York	10	65	91	92	2	22
New York	11	50	92	92	3	24
New York	12	58	74	91	6	23
Massachusetts	13	46	87	88	5	24
Maine	14	59	86	86	8	22
Iowa	15	59	82	82	24	22
Ohio	16	67	96	100	7	24
Wisconsin	18	45	83	83	23	23
Minnesota	19	71	92	92	15	24
Nova Scotia	20	55	86	91	1	22
New Brunswick	21	41	71	77	19	21
Quebec	22	57	96	100	21	23
Quebec	23	42	87	88	27	23
Southern Ontario	24	57	91	100	9	23
Northern Ontario	25	73	86	95	22	22
New Hampshire	27	37	78	84	20	32
Michigan	29	58	92	92	16	12
Virginia	30	50	100	100	11	12

[3]) KING, JAMES P., 1970: Pest susceptibility variation in Lake States jack pine sources. Unpublished manuscript. Unpublished manuscript on file, Northern Institute of Forest Genetics, Rhinelander, Wisconsin.

[4]) Mention of a particular product should not be taken as endorsement by the Forest Service or the U. S. Department of Agriculture.

Many trees that had escaped attack completely or were only fed upon in 1968 were fed upon or had leaders killed in the 1969 and 1970 seasons. At the end of the three-year period, 87.4 percent of all trees had dead leaders, 9.1 percent had been fed upon at least one season, and only 3.5 percent of the trees had displayed complete resistance to attack or had escaped for some other reason.

After three seasons of attack, 9 trees from almost as many sources had sustained moderate to heavy adult weevil feeding each year without noticeable leader damage. Another 18 trees had been fed on during at least two of the three periods and not attacked the third period. Finally, 26 trees were fed upon in one of the three seasons and escaped attack in the other two seasons.

Fowler and Heimburger (1969) suggested that white pine from southern provenances will prove to be more seriously damaged by weevils than those from the northern ones, although they stated that this is only opinion and that their study of 12 provenances did not yet indicate such a relationship. My results did not show this relationship. I found no correlation in either year. I was unable to document a correlation between weeviling in a provenance and latitude of the provenance or between weeviling and tree vigor.

My results suggest that we will be unable to locate a source of eastern white pine that will not be severely damaged by weevil attacks in areas of moderate to heavy weevil populations. The three least- weeviled sources in this study still suffered from 71—77 percent dead leaders, and in height, they ranked 18, 26, and 19, respectively, out of 27 sources.

In the final analysis, it will make little difference whether a tree was not attacked at all or whether it was able to maintain a normal growth rate and form in spite of feeding injury, but the latter category is important in the preliminary observations.

Because this study indicates that selection of entire seed sources for resistance to weeviling will not be possible, we are now thinking more in terms of individual tree selection. Provenance studies such as this one contain a wide variation of genetic material and offer an excellent opportunity to make such selections. I am particularly interested in the 9 individuals that have been fed on for 3 successive years without showing harmful effects. I will also continue to watch those individuals that have been fed on once or twice or not at all. However, although the population of weevils was relatively heavy, there is no guarantee that each tree has been subjected to attack, and I simply may be observing chance escapes in the category of no feeding. Before any tree can be included in an improvement program, weevils will be placed on each tree and caged, if necessary.

The second objective of this study was to observe attack patterns from one season to the next. At the time of remeasurement in 1969, it was obvious that this would not be possible, even though there was a high population of weevils in this area. Many trees with main stem terminal shoots that had been weevil in 1968 failed to develop a dominant lateral that was attacked in 1969.

It should be pointed out that when this planting was established, our primary interest was to determine tree growth and form. The study was not intended to show insect resistance, and the single-tree randomization is not the best design available for this purpose. Trees possessing a degree of resistance may be attacked in this design because of the presence of insects on surrounding nonresistant trees.

Another factor in this type of investigation is the insect population level. If populations are low, successful attacks on some susceptible trees may not occur. On the other hand, even fairly resistant trees may be successfully attacked if populations are extremely high. Populations during this three-year period were higher than in other recent years, but there are no reliable records available to indicate that the 1968—70 levels were exceptional. However, I feel that the conclusions drawn in this report are sound in spite of these deficiencies in design.

This study presented a unique situation in which tree growth in two provenance plantings was being observed while an adjacent planting, containing the same seed sources at the same age, was being observed for weevil resistance. Unfortunately, the results after weevil attacks for three seasons suggest that for timber management purposes all sources have received an unacceptable amount of weevil damage and that future effort, in the case of eastern white pine, should take a different approach.

Summary

This paper reports on the extent of white-pine weevil (*Pissodes strobi* Peck.) injury in a planting that contains 27 provenances of eastern white pine (*Pinus strobus* L.) completely randomized in each of 24 blocks. Differences between provenances in the amount of leader damage as a result of weeviling varied from 71 to 100 percent in 1970. There was no correlation between latitude of seed source or average tree vigor and weevil damage in this study.

The chance of locating provenances with acceptable levels of resistance are remote and alternative methods of producing weevil resistant material should be followed.

Zusammenfassung

Es wird über das Ausmaß der von *Pissodes strobi* verursachten Schäden in einer *Pinus strobus*-Pflanzung mit 27 Provenienzen berichtet, die auf einer Fläche in 24 Blocks vollständig randomisiert angebaut worden waren. 1970 variierten die verursachten Triebschäden bei den Provenienzen zwischen 71% und 100%. Es fand sich aber dort keine Korrelation zwischen dem Breitengrad der Herkunft oder der Baumstärke und den *Pissodes*-Schäden.

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