The Great Lakes Entomologist

Volume 15
Number 3 - Fall 1982 *Number 3 - Fall 1982*

Article 12

October 1982

Susceptibility of White Spruce Seed Sources to Yellowheaded Spruce Sawfly, *Pikonema Alaskensis*,(Hymenoptera: Tenthredinidae)

Michael D. Connor
USDA Forest Service

Mark W. Houseweart
University of Maine

Herbert M. Kulman
University of Minnesota

Recommended Citation

Connor, Michael D.; Houseweart, Mark W.; and Kulman, Herbert M. 1982. "Susceptibility of White Spruce Seed Sources to Yellowheaded Spruce Sawfly, *Pikonema Alaskensis*,(Hymenoptera: Tenthredinidae)," *The Great Lakes Entomologist*, vol 15 (3)
DOI: https://doi.org/10.22543/0090-0222.1438
Available at: https://scholar.valpo.edu/tgle/vol15/iss3/12

SUSCEPTIBILITY OF WHITE SPRUCE SEED SOURCES TO YELLOWHEADED SPRUCE SAWFLY, *PIKONEMA ALASKENSIS*, (HYMENOPTERA: TENTHREDINIDAE)[1]

Michael D. Connor,[2] Mark W. Houseweart,[3] and Herbert M. Kulman[4]

ABSTRACT

A field caging technique was used to test the susceptibility of 25 white spruce, *Picea glauca* (Moench) Voss, seed sources to attack by *Pikonema alaskensis* (Rohwer). No significant differences were found in the number of eggs laid, number of dessicated eggs, or number of egg slits. Percent oviposition differed significantly within a tree, the south side having more eggs. Bud size differed significantly within trees and between trees but not between seed sources. The number of sawfly eggs laid on a bud could not be related to bud size. There was no significant difference in susceptibility of the seed sources studied to *Pikonema alaskensis*.

The yellowheaded spruce sawfly, *Pikonema alaskensis* (Rohwer), is a Nearctic species occurring transcontinentally in Canada and northern United States, coinciding with the range of white spruce, *Picea glauca* (Moench) Voss. Plantations, nurseries, shelterbelts, and ornamentals are especially susceptible. Plantations are usually not attacked until 3–5 years after planting (Nash 1939). Some mortality does occur, but growth loss is the greatest economic impact caused by this sawfly (Kulman 1971).

The biology of *P. alaskensis* is well documented from Maine studies (Nash 1939). The bionomics and natural mortality agents of yellowheaded spruce sawfly in Minnesota have been reported by Houseweart and Kulman (1976a, 1976b) and Schoenfelder et al. (1978).

Studies of tree resistance to sawfly attack are limited. Wilson (1966) reported ponderosa pine, *Pinus ponderosa* Laws., from seed collected in the Deschutes region of Oregon was lightly attacked by European pine sawfly, *Neodiprion sertifer* (Geoff), in Michigan, possibly indicating resistance. Wright et al. (1967) examined Scotch pine, *Pinus sylvestris* L., and found variety *uralensis* was attacked less by European pine sawfly than other varieties of comparable heights. Pauley and Mohn (1971) studied defoliation by *P. alaskensis* in a northeast Minnesota provenance test of 23 white spruce seed sources. They reported no consistent evidence in frequency of attack between white spruce seed sources. Nienstaedt and Teich (1972) reported preferential feeding by yellowheaded spruce sawfly occurred on trees from 28 seed sources growing in northeast Minnesota. Differences apparently occurred only when sawfly infestations were low because no differences were found in another Minnesota test of the same provenances heavily infested by the sawfly.

Pointing (1957) stated that emergence of *P. alaskensis* and expanding shoot growth were well synchronized. Eggs were not found on shoots where bud scale caps covered greater than 60% of the needles. At the other extreme, fully expanded shoots had needles which diverged considerably and were so flexible that penetration by the female's ovipositor was impossible.

Cook (1978) reported no yellowheaded spruce sawfly eggs were found on shoots $< 100\ mm^3$ in volume and few were found on shoots with a volume $> 1000\ mm^3$. Since

---

[1]Paper No. 12,173 Minnesota Agricultural Experiment Station.
[2]USDA Forest Service, Southeastern Area, Forest Pest Management, Pineville, LA 71360.
[3]Cooperative Forestry Research Unit, University of Maine, Orono, ME 04469.
[4]Department of Entomology, Fisheries and Wildlife, University of Minnesota, St. Paul, MN 55108.

adults are short lived, 3–14 days, the synchronization of emergence with bud flush is critical. Differences in initiation of bud flush in white spruce clones have been shown to be as great as 21 days (Nienstaedt and King 1969). Differences this great between seed sources may make some sources unsuitable for oviposition.

The objectives of this study were to determine (1) if there were differences in the ability of females to oviposit on different white spruce seed sources, (2) if there were differences in the ability of larvae to feed and survive on different white spruce seed sources, and (3) if differences exist, were they related to bud size or volume.

MATERIALS AND METHODS

Twenty-five white spruce seed sources and one black spruce, *Picea mariana* (Mill.) B.S.P., source were planted north of Grand Rapids, Minnesota, in 1962 as a provenance study. Seed sources were planted in a randomized complete-block design with four-tree plots in each of 10 blocks. Tree spacing was 2.4 m by 2.4 m Three replicates from the plantation were randomly chosen for the study. The first three trees in each source were utilized. If any of the first three trees was unusually small or deformed, it was skipped and the fourth tree utilized.

Yellowheaded spruce sawfly larvae were collected in 1975 near Grand Rapids and reared in the laboratory using a technique developed by Houseweart and Kulman (1976b). Approximately 4000 cocoons were overwintered using schedules patterned after those developed by Houseweart et al. (1977), as yielding the least mortality in laboratory rearing. Two groups of 2000 each were used with staggered schedules of 1.5 weeks to result in different emergence times. This allowed for variable weather conditions, so field introductions would coincide with the naturally emerging sawfly flight period.

In May 1976, dacron marquisette (27 threads/cm) cages supported by a 14 gauge wire frame were tied to an east and south branch of three trees from each of the 26 seed sources for each of three replicates (total of 468 bags). The sawfly prefers sunlit areas, so cages were not placed at a uniform height, but rather where shading would be minimal. Therefore, cage height varied between trees due to placement at mid-upper crown regardless of total tree height. However, within a tree both cages were placed at approximately the same height. Before placing cages on the trees, branches were sprayed with pyrethrum to ensure no predators or parasites were present. Sawflies were placed in cages between 18 to 23 May 1976. Males were observed flying around cages containing females on 19 May, and field populations of females were seen ovipositing on 21 May, confirming that the females were caged at the proper time. Cages were checked daily for dead females. After females died, they were removed from the cages, placed in KAAD for 48 h, and then stored in 95% ethyl alcohol until dissection for counts of unlaid eggs. After removal of female sawflies the branches were examined for the number of eggs laid, dessicated eggs, number of oviposition slits without eggs, and number of buds available for oviposition. Potential fecundity and percent oviposition were calculated.

On 21 and 23 May, length and width of flushed buds adjacent to sleeve cages and approximately the same size as those in the sleeve cage were measured using a hand micrometer. Approximate volume of the shoots was calculated using the formula for a cylinder.

Destructive sampling was used to sample third and fifth instar larvae to determine larval mortality. Instar determinations were made from head capsule measurements as determined by VanDerwerker and Kulman (1974).

Data were analyzed by ANOVA using an interactive computer program, IVAN (Weisberg and Koehler 1976).

RESULTS AND DISCUSSION

There were no significant differences ($P > 0.10$) in the number of eggs laid by yellowheaded spruce sawfly on different white spruce seed sources (Table 1). However, there was a wide range in the average number of eggs laid on each seed source (Table 2). The percent natural defoliation is given in Table 3 to provide an index of feeding on the various sources.

Table 1. Analysis of variance table for the number of yellowheaded spruce sawfly eggs laid on caged branches of 25 white spruce seed sources (df = degrees of freedom, SS = sum of squares, MS = mean square).

Source of variability	df	SS	MS	F
Source	24	20,607.0	858.6	1.15
Replicate	2	4,523.1	2261.5	6.51[a]
Source × replicate	48	35,268.0	734.8	2.12[a]
Among trees	150	71,693.2	478.0	1.38[b]
Direction	1	887.6	887.6	2.55
Source × direction	24	7,444.6	310.2	0.89
Error	200	69,486.7	347.4	—
TOTAL	449	209,910		

[a]Significant at the 0.01 level.
[b]Significant at the 0.05 level.

Table 2. Average number of eggs of the yellowheaded spruce sawfly laid on caged branches of 25 white spruce seed sources.

Source and location	Mean number of eggs (replications combined)	Standard error
1661 Quebec	23.3	3.2
1654 Alaska	23.3	4.9
1659 N. Brunswick	25.6	3.6
1664 Manitoba	26.9	5.6
1676 Michigan	28.5	4.7
1662 Ontario	28.7	4.5
1645 Wisconsin	29.9	3.7
1653 Alaska	30.7	4.5
1631 Manitoba	31.9	3.8
1658 Labrador	34.4	3.8
3511 Minnesota	34.6	4.7
1649 N. Hampshire	35.1	5.0
1660 Quebec	35.2	5.2
1686 Ontario	35.3	5.1
1655 Maine	35.6	3.7
1647 Minnesota	36.6	7.0
1687 Ontario	37.2	5.8
1665 Saskatchewan	37.6	6.7
1628 S. Dakota	38.5	3.9
1630 Montana	41.1	4.8
1669 Minnesota	42.4	4.5
1657 Labrador	43.5	5.4
1644 N.Y.	43.7	6.2
1663 Ontario	45.5	6.3
1677 B.C.	49.2	5.5

There were no significant differences in the number of dessicated eggs or number of ovipositional slits without eggs by seed source, tree, or direction.

Percent oviposition was significantly different ($P < 0.025$) due to direction. The average percentage of eggs laid for the east and south direction was 73.6% and 67.9%, respectively.

If differences in bud size occurred among seed sources the result could be differences in the number of eggs laid by sawflies. However, bud width and length differed significantly ($P < 0.005$) only by direction. Bud volume differed significantly between trees ($P < 0.10$) and by direction ($P < 0.005$), the southerly direction having larger buds. Wilkinson (1977) reported only a 5-day variation in budbreak of 37 half-sib families of white spruce in southern Maine. He also reported that differences between individual trees were greater than those between families. Possibly a relationship exists between bud size and number of eggs laid, but since variation between and within trees is greater than variation between seed sources the result is no detected difference in number of eggs laid on different sources.

From Pointing's (1957) observations, yellowheaded spruce sawfly was expected to lay few eggs on small buds, most eggs on an optimum bud size, and few eggs on large buds with diverged needles. Although Cook (1978) found this to be true, this was not the case when the sawfly was caged on branches. Eggs were laid on a bud 10 mm^3 at the time of oviposition. The largest buds measured were 2168 and 2072 mm^3, and 5 and 27 eggs, respectively, were laid on adjacent caged buds. Possibly, under natural conditions in a stand of trees with variable-sized buds, sawflies would select the most suitable tree. However, when caged and restricted to a particular tree, the sawfly will lay eggs even on very small buds. It is also

Table 3. Percent of natural defoliation of 25 white spruce seed sources by the yellowheaded spruce sawfly in August 1975, at Grand Rapids and Cloquet, Minnesota.

Grand Rapids, Minn.			Cloquet, Minn.		
Seed source	Mean % defoliation	Std. error	Seed source	Mean % defoliation	Std. error
1657	0.3	0.2	1657	0.6	0.4
1669	0.4	0.2	1653	2.8	1.9
1644	0.9	0.4	1645	3.1	1.7
1687	1.0	0.5	1655	3.1	1.9
1665	1.2	0.4	1665	3.9	2.6
1659	1.4	0.5	1669	5.3	2.3
1647	1.9	0.6	1631	5.6	1.5
1660	1.9	0.6	1628	5.8	2.4
1628	1.9	0.7	1664	6.5	1.9
1662	2.1	0.7	1663	6.6	2.8
1645	2.3	0.8	1658	6.8	2.9
1658	2.6	0.8	1659	7.4	3.8
1676	2.6	0.8	1687	8.6	1.4
1686	2.9	1.5	1686	9.1	3.7
3511	2.9	0.8	1647	9.2	2.3
1631	3.3	0.7	1662	9.5	2.2
1663	3.3	1.8	1644	10.0	2.7
1664	3.7	1.1	1649	10.9	4.1
1661	4.1	2.0	1661	11.1	2.8
1630	4.3	1.2	1676	11.5	5.1
1649	4.6	1.2	1677	11.5	5.5
1655	5.1	2.3	3511	11.7	3.2
1653	6.8	2.6	1660	11.9	4.9
1677	8.8	2.4			
1654	10.0	2.9			

possible that other factors (i.e., odors) which may cause preference under natural conditions were overriden by caging.

No significant differences existed among the seed sources in larval mortality from egg to the third larval instar or from the egg to the sixth larval instar.

This study found no significant differences in susceptibility of the 25 white spruce seed sources studied to yellowheaded spruce sawfly attack when sawflies were caged on trees. Any susceptibility differences that exist must be due to sawfly preference and not to inherent tree resistance. Of the seed sources tested, this study indicated no reason for considering the yellowheaded spruce sawfly in provenance selection.

ACKNOWLEDGMENT

Appreciation is expressed to Dr. Lynne Thompson for advice and assistance in the field; Dr. S. Weisberg for assistance in experimental design and analysis; Dr. C. A. Mohn, William Cromwell, and Charles K. Blandin Foundation for coordinating their activities and allowing the use of the provenance study for this research; Drs. R. J. Bartelt and George W. Ryan for review of the manuscript; and Barbara Clausen and Gary Glonek for laboratory technical assistance. The study was supported by the University of Minnesota Agricultural Experiment Station and Computer Center.

LITERATURE CITED

Cook, J. L., M. W. Houseweart, H. M. Kulman, and L. C. Thompson. 1978. Foliar mineral differences related to sawfly defoliation of white spruce. Environ. Entomol. 7:780–781.

Houseweart, M. W. and H. M. Kulman. 1976a. Fecundity and parthenogenesis of the yellowheaded spruce sawfly, *Pikonema alaskensis*. Ann. Entomol. Soc. Amer. 69:748–750.

———. 1976b. Life tables of the yellowheaded spruce sawfly, *Pikonema alaskensis* (Rohwer) (Hymenoptera: Tenthredinidae) in Minnesota. Environ. Entomol. 5:859–867.

Houseweart, M. W., D. E. Rau, and H. M. Kulman. 1977. Temperature schedules for overwintering yellowheaded spruce sawfly cocoons in the laboratory. Minnesota For. Res. Note 259. 4 p.

Kulman, H. M. 1971. Sawfly defoliation affects shoot growth of white spruce—a preliminary report. Minnesota For. Res. Note 223. 3 p.

Nash, R. W. 1939. The yellow-headed spruce sawfly in Maine. J. Econ. Entomol. 32:330–334.

Nienstaedt, H. and J. P. King. 1969. Breeding for delayed budbreak in *Picea glauca* (Moench) Voss: Potential frost avoidance and growth gains. p. 61–80 *in* Proc. 2nd World Consult. For. Tree Breed. Washington, D.C., 1969.

Nienstaedt, Hans and A. H. Teich. 1972. Genetics of white spruce. USDA For. Serv. Res. Pap. WO-15. 24 p.

Pauley, S. S. and C. A. Mohn. 1971. Selective defoliation by the yellow-headed spruce sawfly. Minnesota For. Res. Note No. 229. 4p.

Pointing, P. J. 1957. Studies of the comparative ecology of two sawflies, *Pikonema alaskensis* (Rohwer) and *Pikonema dimmocki* Cress. Ph.D. thesis, Univ. Toronto. 147 p.

Schoenfelder, T. W., Mark W. Houseweart, H. M. Kulman, and F. B. Martin. 1978. Insect and mammal predation of yellowheaded spruce sawfly cocooons (Hymenoptera: Tenthredinidae). Environ. Entomol. 7:711–713.

VanDerwerker, G. K. and H. M. Kulman. 1974. Stadium and sex determination of yellowheaded spruce sawfly larvae, *Pikonema alaskensis*. Ann. Entomol. Soc. Amer. 67:29–31.

Weisberg, Sanford and Kenneth J. Koehler. 1976. IVAN Users Manual. Version 1.0 Technical Rept., #266. School of Statistics, Univ. Minnesota. 33 p.

Wilkinson, R. C. 1977. Inheritance of budbreak and correlation with early height growth in white spruce (*Picea glauca*) from New England. USDA For. Serv. Res. Pap. NE-391. 5 p.

Wilson, L. F. 1966. Relative susceptibilities of three ponderosa pine sources to European pine sawfly (Hymenoptera: Diprionidae) attack in Michigan. Mich. Entomol. 1:23–25.

Wright, J. W., L. F. Wilson, and W. K. Randall. 1967. Differences among Scotch pine varieties in susceptibility to European pine sawfly. For. Sci. 13:175–181.