ISSN 0317-6908

bi-monthly research notes

Vol. 34, No. 6, NOVEMBER-DECEMBER 1978

Environment Canada | Environnement Canada

Forestry Service | Service des forêts

bi-monthly research notes

A selection of notes on current research conducted by the Canadian Forestry Service and published under the authority of the Minister of the Department of the Environment. A French edition is published under the title of Revue bimestrielle de recherches.

TASK FORCE STUDIES BUDWORM RESEARCH

Current Canadian eastern spruce budworm research is being reviewed by a Canadian Forestry Service task force convened in early July under the leadership of Dr. Chris Sanders, Great Lakes Forest Research Centre. The membership includes Dr. D.R. Wallace, also of the Great Lakes Forest Research Centre, Dr. O.N. Morris, Forest Pest Management Institute, Dr. A.W. Thomas, Maritimes Forest Research Centre, and Dr. G.L. Baskerville, Professor of Forest Ecology, University of New Brunswick. Two Americans, Dr. Lloyd Irland, State of Maine, and Dr. Dan Schmitt, Program Manager (East) CANUSA, Broomal, Pa., complete the team. The United States component will prevent overlapping of the CANUSA and continuing programs.

The task force has already reviewed ongoing CFS eastern spruce budworm research and related it to the subtargets of the Convergence Analysis Schedule. This has been the first step in establishing CFS short-term (5-year), medium-term (10-year), and long-term (20-year) research priorities.

The next step, beginning in October, is to interview the responsible provincial forest managers to ensure that research recommendations conform to management needs. It entails visits to all eastern provincial jurisdictions. The task force team is to interview senior management decision-makers and define CFS forestry research priorities in terms of forest management needs.

After management interviews the task force will interview scientists in regional establishments to interpret managerial needs in accordance with scientific feasibility. Each major segment of the spruce budworm program will thus be approached from the viewpoint of the needs and objectives of both resource managers and research scientists.

The task force will recommend the direction spruce budworm research should take in terms of modern requirements. CFS establishment directors support the task force both in composition and in expected results. Resource manager–research scientist interaction will revitalize and integrate a sound spruce budworm research program.

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ENTOMOLOGY

Foliar Spray of Acephate Ineffective against Mountain Pine Beetle in Lodgepole Pine.—Lodgepole pine (*Pinus contorta* Dougl.) is being killed by the mountain pine beetle (*Dendroctonus ponderosae* Hopk.) in many parts of central and southern British Columbia. Except for a short flight period, all life stages of the beetle exist under the bark, where the broods are protected from all nonsystemic insecticides applied from the air and from surface-applied insecticides that also do not kill the tree. An effective nonphytotoxic systemic insecticide, applied to the foliage, could kill these insects and possibly keep the tree alive if the insecticide was translocated down the phloem from the crown in concentrations toxic to the beetles feeding on the inner bark.

Acephate (orthene: O,S-dimethylacetylphosphoramidothioate) is a water-soluble systemic insecticide that remains active for about 10-15 days (Chevron Chemical Co., technical information experimental data sheet on Orthene insecticide, October 1972), metabolizing to methamidophos (monitor: O,S-dimethylphosphoramidothioate), which is also an insecticide. Acephate, sprayed at 1 kg active ingredient/500 L, has been shown to be translocated basipetally from the crowns of loblolly pines (*Pinus taeda* L.) in sufficient quantities to kill beetles (Williams et al., Small scale field experiment to evaluate the phloem mobility of Orthene and Monitor in southern pines [unpublished], USDA, Pac. Southwest Forest and Range Exp. Stn., Berkeley, Calif., 1974).

In 1975, an experiment was undertaken in British Columbia, near Williams Lake, to determine whether a foliar spray application of acephate at medium-to-high concentrations would translocate from the foliage down the phloem of lodgepole pine immediately after attack by the first bark beetles and cause mortality of mountain pine beetle adults and larvae feeding in the phloem.

Six unattacked lodgepole pines, selected for treatment before beetle flight in an active mountain pine beetle infestation at Bull Mountain, were baited with two polyethelene containers, each containing the aggregative pheromone *trans*-verbenol. Attacks began first on baited trees about 23 July. After flight, we found that there was no difference in attack density between baited and eight adjacent nonbaited attacked trees, and the distinction was dropped from the analysis. Within 3 days after the trees sustained the first few attacks, 11 trees were sprayed with acephate in water at the rates of either 1.12 or 5.60 kg a.i. per hectare. Three of the trees sprayed at 5.60 kg a.i. per hectare were resprayed at the same rate 14 to 18 days later, when attacking beetles had established galleries and laid eggs. The sprays were applied to all the foliage by a backpack mist blower, after the operator had climbed by ladders into the lower crowns. All sprays were carried out on warm, sunny days with little or no wind, days that are considered ideal for achieving maximum spray deposit on foliage.

At the end of August, 20 days after the second spray, all trees were felled and bolts were removed from the butt and crown to determine the effects of the pesticide. Bolts from the butt were cut in half: one half was kept at +21°C to allow completion of brood development; the other was debarked to assess brood and parent survival. The crown sections and inner bark of the second butt section were placed at −26°C to arrest metabolization of any remaining insecticide.

The initial assessment showed no significant difference in survival of parents or brood between any of the treatments and the checks. The same results were obtained from the second assessment, when broods were permitted to reach maturity, showing that acephate had no effect on beetle survival when applied to the foliage at either 1.12 or 5.60 kg a.i. per hectare.

Inner bark samples of butt and crown sections were analyzed on a gas-liquid chromatograph after the method of Leary (J. Assoc. Off. Agric. Chem. 57(1):189-191, 1974), with a few modifications to adapt the method to available equipment. Later, some samples were checked with glc-mass spectrometer by Dr. D. McGillvry, Chemistry Department, University of Victoria. No traces of acephate or methamidophos were found in any test samples, possibly because of the complete metabolic breakdown of both insecticides during the interval between spraying and felling.

The lack of differences of survival among treatments shows that acephate, applied at high spray concentrations to pine foliage immediately after stem attack by mountain pine beetle, was ineffective in *controlling the beetle population.*—P.M. Hall, E.D.A. Dyer, and E.E. McMullan, Pacific Forest Research Centre, Victoria, B.C.

The Multiplication of *Nosema fumiferanae* (Microsporida) in Spruce Budworm Reared on Three Different Diets.—The development of synthetic diets has greatly simplified the rearing of insects for experimental studies. Availability of a suitable diet eliminates the need for growing or preserving natural food for use in the winter months. Although Bergold (Can. J. Zool. 29:17-73, 1951) demonstrated that quick-frozen balsam fir (*Abies balsamea* [L.] Mill.) buds are an acceptable food for rearing spruce budworm, *Choristoneura fumiferana* (Clem.), their use necessitates collection at appropriate growth stages, and suitable low-temperature storage space. Substitution of synthetic diets eliminates such difficulties.

If insects used in host-parasite studies are reared on synthetic diets, it is important to know the effects of such diets on the parasite. The synthetic diet (McMorran, Can. Entomol. 97:58-62, 1965) now in use usually contains antimicrobial agents (formalin, methyl parahydroxybenzoate, Aureomycin) to prevent the growth of contaminants such as fungi and bacteria, and these antimicrobial agents may also affect the parasite.

To determine the effects of the McMorran diet on the ability of microsporidia to develop, second instar spruce budworm larvae (from the

TABLE 1

The effects of a synthetic diet and a diet of balsam fir buds and white spruce buds on the number of *Nosema fumiferanae* spores produced in its host, the spruce budworm

Observations	Balsam	Spruce	Synthetic
Number of larvae	17	23	29
Mean spore count per mg dry weight ($\times 10^6$) ± standard error	17.3±3.1[a]	18.3±3.1[a]	20.5±2.7[a]

[a] Means are not significantly different at the 5% level.

same population) naturally infected with *Nosema fumiferanae* (Thom.) were reared on three diets: a synthetic diet and fresh buds of either balsam fir or white spruce (*Picea glauca* [Moench] Voss). The diets were placed in 28.35 g (1 oz) plastic cups, sealed with parafilm under the lid. Six cups were used with each diet, approximately six larvae being placed in each cup. Insects were reared at room temperature (21-23°C) and RH 40-60%. The cups were examined every 3 days, and wilted or deteriorated buds were replaced with fresh buds, and dead larvae discarded.

Larvae were removed from the diets just before pupation (18-22 days), frozen, and air-dried, and the microsporidian spores were counted by the procedure described by Wilson (Can. Entomol. 108:383-386, 1976). Table 1 shows that similar spore counts were obtained from the larvae on all test diets, which suggests that the ingredients of the synthetic diet had no effect on the ability of the microsporidia to multiply.—G.G. Wilson, Forest Pest Management Institute, Sault Ste. Marie, Ont.

Chemical Control of a Seed-boring Sawfly and a Midge Damaging Chokecherry in Alberta.—The common chokecherry, *Prunus virginiana* L., grows abundantly throughout the Prairie Provinces along field edges, wetlands, and wooded areas. The astringent black berries are used extensively as food by mammals and birds and to a lesser degree by man. The fruit was added to pemmican and was of considerable importance to pioneers for making jams, jellies, and wine. Recently there has been renewed interest in the market potential of these products.

The life history of the midge has not been published. Preliminary observations indicate that adults emerge in May and that the female lays its eggs somewhere in the flowers shortly after mating. The egg hatches in a few days, and the yellowish orange maggot enters the developing fruit. Several maggots feed within the same fruit, causing it to become enlarged and somewhat pear-shaped and the seed to abort. Feeding continues until late July, when the mature larva abandons the enlarged, hollow fruit through a crescent-shaped opening and drops to the ground to pupate in the soil. Shortly thereafter the damaged fruit desiccates and usually falls to the ground.

Chemical control field tests were begun in 1975 with two mist-blower and one ultra-low-volume foliar spray applications. In 1976, seven mist-blower and one ultra-low-volume sprays were applied. Each plot was 0.04 ha in size and contained shrubs averaging 3 m in height. The mist-blower solutions were applied at the rate of 9.1 L (3.1 mL/L active ingredient) per treatment with 4.7 mL of Atplus spreader/sticker added. Ultra-low-volume treatments were made with Turbair oil-base formulations; one containing 1.8% malathion and the other 0.69% resmethrin were each applied at the rate of about 40 mL per treatment. In 1977, ten spray treatments with five insecticides were applied with a mist blower. Plots were 0.02 ha in size and contained shrubs averaging about 3 m in height. Spray solutions were applied at the rate of 4.5 L (3.1 mL/L active ingredient) per plot, with alternate plots treated at half this dosage (1.5 mL/L active ingredient). Chemicals were applied about peak petal drop to reduce bee mortality. Percentage insect control was determined by

TABLE 1

Percentage control of *Hoplocampa lacteipennis* and *Contarinia virginianiae* based on fruit counts on ten 45-cm chokeberry branches selected at random after treatment with 10 insecticides, 1975-77

Material	Dosage a.i.[2]/L	No. fruit attacked by: Total no. fruit			Midge			Sawfly			Control %			Phytotoxicity[1]		
		1975	1976	1977	1975	1976	1977	1975	1976	1977	1975	1976	1977	1975	1976	1977
Diazinon	3.1 mL	1,180	1,797	1,031	0	0	0	4	4	4	100	100	95	M	L	T
Diazinon	1.5 mL	—	—	765	—	—	0	—	—	1	—	—	99	—	—	—
Dimethoate	3.1 mL	—	1,749	—	—	0	—	—	0	—	—	100	—	—	M	—
Malathion	3.1 mL	633	1,342	—	4	0	—	27	0	—	99	100	—	T	T	—
Malathion (ULV[3])	18.0 mL	—	2,222	—	—	0	—	—	21	—	—	100	—	—	—	—
Oxydemeton-methyl	3.1 mL	—	1,732	—	—	0	—	—	0	—	—	100	—	T	—	—
Propoxur	3.1 mL	—	1,509	949	—	1	0	—	0	1	—	100	99	—	T	T
Propoxur	1.5 mL	—	—	1,081	—	—	0	—	—	1	—	—	100	—	—	—
Phosphamidon	3.1 mL	—	2,173	—	—	0	—	—	0	—	—	100	—	—	L	—
Trichlorfon	3.1 mL	—	—	1,105	—	—	0	—	—	0	—	—	99	—	—	T
Trichlorfon	1.5 mL	—	—	1,015	—	—	0	—	—	46	—	—	41	—	—	—
Trichlorfon and oxydemeton-methyl	3.1 mL	—	—	991	—	—	0	—	—	22	—	—	71	—	—	T
Trichlorfon and oxydemeton-methyl	1.5 mL	—	—	852	—	—	0	—	—	3	—	—	96	—	—	—
Ambush	3.1 mL	—	—	1,005	—	—	0	—	—	0	—	—	100	—	—	T
Ambush	1.5 mL	—	—	990	—	—	0	—	—	0	—	—	100	—	—	—
Resmethrin (ULV)	6.9 mL	442	—	—	23	—	—	51	—	—	95	—	—	—	—	—
Control 1		329	1,247	848	30	51	1	68	186	64	—	—	—	—	—	—
Control 2		411	1,975	619	4	1	0	55	120	32	—	—	—	—	—	—

[1] Phytotoxicity: T = trace, L = light, M = medium.
[2] Active ingredient.
[3] Ultra low volume.

The most common insects attacking the fruit of chokecherry are a seed-boring sawfly, *Hoplocampa lacteipennis* Rohwer, and the chokecherry midge, *Contarinia virginianiae* (Felt). The life history of the sawfly was described by Bird (Sci. Agric. 8:497-501, 1928). The adults feed on the nectar and pollen of chokecherries in late May, and the females lay their eggs in pockets cut into the flower calyx. The larva emerges in about 5 days and enters and feeds within the developing cherry, which subsequently dries up and turns black. After molting, the larva enters a second fruit and feeds in a zigzag manner on the outer shell of the seed, eventually boring through the hard shell and destroying the soft interior of the seed. In early August, or about the time the fruit begins to ripen, the larva bores a hole directly to the outside and drops to the ground. It overwinters in the soil and pupates the following spring. The infested cherries ripen along with the sound fruit, but are easily distinguished by the exit hole.

applying Abbott's formula to data obtained by examining the fruit on ten 45-cm branches randomly selected from each of the treatment and control plots approximately 11 weeks later.

The chokecherry midge was less abundant in the general test areas in 1976 and 1977 than in 1975; however, the seed-boring sawfly infestations remained fairly constant. All the insecticides tested gave excellent control over both insect species, except the low-dosage application of trichlorfon, which gave fair control of the seed-boring sawfly (Table 1). No signs of phytotoxicity occurred with the low-dosage applications. Most other applications, however, caused at least a trace of phytotoxicity, occasionally more. Fruit counts from the chokecherry branches sampled in 1977 average 978 berries per treated plot and 733 per untreated plot — 33% more in the treated area. Sprays are most effective when applied during petal drop.—J.A. Drouin and D.S. Kusch, Northern Forest Research Centre, Edmonton, Alta.

The Mountain Pine Beetle in Alberta.—Safranyik et al. (Environ. Can., For. Tech. Rep. 1, 1974) stated that "the mountain pine beetle (*Dendroctonus ponderosae* Hopk.) is the most serious enemy of mature pines in western Canada." In his revision of the species in this genus, Wood (Great Basin Nat. 23[1-2]:57-69, 1963) stated that the mountain pine beetle occurred from southern British Columbia to the Black Hills of South Dakota, and south to northern Mexico. He gave only a vague account of its distribution in Alberta, recording a specimen from Edmonton and indicating in his Fig. 52 that the probable geographical distribution of *D. ponderosae* included western Alberta. Powell (Dep. For. Inf. Rep. A-X-2, 1966), however, concluded that the Edmonton collection reported by Wood was questionable, because (1) a search in the collection on which this report was based failed to locate the specimen, and (2) there are only a few pine in Edmonton. He went on to note that Wood's probable distribution of *D. ponderosae* in Alberta is much farther north than where any collections have been made and appears to be based on the distribution of the host species. The recent publication by Bright (Agric. Can. Publ. 1576, 1976) on the bark beetles of Canada and Alaska indicated essentially the same distribution for the mountain pine beetle as Wood. The Edmonton collection noted by Wood was, however, excluded, and only in Bright's distribution map is *D. ponderosae* shown to be present in Alberta. This paper brings up to date the status of this insect in Alberta.

The first report of an outbreak of the mountain pine beetle in the province was in the Bow River valley and tributaries near Banff in 1940 (Hopping and Mathers, For. Chron. 21:98-108, 1945). The total area infested was 4 070 ha. The cutting and burning of infested trees in 1941-43, in conjunction with 12 days of subzero weather in the middle of January 1943, apparently reduced populations of the insect to endemic levels. Although the occasional adult of *D. ponderosae* has been collected (Seebe in 1948, north of Coleman in 1969, and southwest of Pincher Creek in 1970), no subsequent infestations were noted in Alberta until 1977.

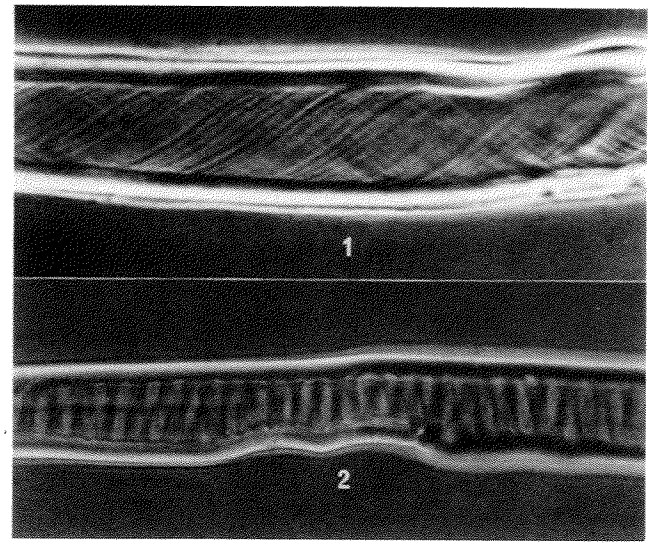
In 1977, adults of the mountain pine beetle were collected, and fresh pitch tubes were observed on green infested trees in Waterton Lakes Forest at Sharp Creek, near the south end of West Castle River, and in and around the Syncline Campground 11.2 km southwest of Beaver Mines. In the last-mentioned area, the presence of several dead trees indicated that the infestation had been present for at least 3 years. Numerous red tops were observed in the Blood Indian Timber Reserve, headwaters of the Carbondale River, and south of Blairmore. This suggests that the infestation is fairly extensive—H.R. Wong and J. Petty, Northern Forest Research Centre, Edmonton, Alta.

MISCELLANEOUS

Tracheids of Boreal and Tree-line Tamarack (*Larix laricina*).—Paleobotanists and wood technologists often have difficulty in differentiating between *Larix* and *Picea* driftwood and subfossil wood samples from the Arctic and Subarctic (Blake, pages 77-104 *in* Proc., Symposium on climatic changes in Arctic areas during the last ten-thousand years, Univ. Oulu, Finland, 1972). This paper describes the structure of tracheids in *Larix laricina* collected from boreal and tree-line locations. The information it gives, supplemented by the anatomical descriptions found in Panshin and de Zeeuw (Textbook of wood technology, third ed., McGraw-Hill, New York, 1970), may be useful to arctic investigators for identifying unknown wood samples.

Specimens of tamarack were collected by S.C. Zoltai, arctic ecologist at the Northern Forest Research Centre, from Smoky Lake, Alta. (54° 15'N and 112° 08'W); Macdowall, Sask. (53° 02'N and 106° 05'W); Newfoundland (49° 08'N and 56° 04'W), in the boreal region; open gallery forest surrounded by tundra at Anderson River, N.W.T. (68° 50'N and 128° 26'W); open black spruce-lichen forest at Mountain River, N.W.T. (65° 33'N and 128° 51'W); forest patch in tundra at Tha-Anne River, N.W.T. (61° 11'N and 97° 09'W); forest patch in tundra at Downer Lake, N.W.T. (60° 31'N and 97°04'W); and the Newfoundland barrens (49° 00'N and 57° 05'W) in the tree-line region.

The tracheid structure of wood samples was examined microscopically in radial and tangential sections to identify the group and tentatively determine the genus. Macerations in a 1:1 mixture of glacial acetic acid and 15% hydrogen peroxide, as well as sections, were used for species identification and confirmation of group and genus. Tree-line tamarack from the Northwest Territories and Newfoundland consistently had thickenings in the summerwood tracheids in growth rings of all specimens.



Figures 1 and 2. Tracheids with spiral thickenings from tree-line tamarack.
Figure 1. Thin, almost 45°-angled spiral thickenings.
Figure 2. Thick, almost right-angled spiral thickenings.

These spiral thickenings were of two kinds: (1) thin, almost 45°-angled, closely spaced (Fig. 1), and (2) thick, almost right-angled, widely spaced (Fig. 2). Type 1 was more common in most tree-line samples except the specimen from Newfoundland, in which both occurred in almost equal proportions.

There were no type 1 spiral thickenings in boreal summerwood tracheids from Saskatchewan and Alberta specimens. Type 2 thickenings occurred intermittently in growth rings of some of these trees. The Newfoundland specimen had both type 1 and type 2 spiral thickenings in all growth rings; type 2 was most prevalent.

Springwood tracheids invariably had spiral checks in the outer wall similar to the one reported by Panshin and de Zeeuw (1970, Fig. 14B). Spiral checks, however, occur at regular or irregular intervals in many species, often open-cleaved, and have little diagnostic value. Composite structures and deformities in tracheids similar to those illustrated from frost burl tissues in pine and spruce (Zalasky, Can. J. Bot. 53:1888-1898, Figs. 20, 29, 33, 35, 37, 38, 1975) are also of no diagnostic value because the anomalies occur in most species.

To determine whether the wood is a species of *Larix* or of *Picea* the diagnostically important characteristics of all cell structures of boreal species lacking spiral thickenings in tracheids must be examined. The variability in the angle and spacings of spiral thickenings in tamarack helps to distinguish this species from other species of *Larix* that have more constancy in the angle and spacing of spiral thickenings. The closely spaced fine spirals are observed more readily in macerations than in sections.—Harry Zalasky, Northern Forest Research Centre, Edmonton, Alta.

INSECT PATHOLOGY

Experimental Aerial Application of *Bacillus thuringiensis* for Spruce Budworm Control.—Slow progress in developing spray technology for the aerial application of *Bacillus thuringiensis* has delayed operational use of this biological control agent against spruce budworm. Accordingly, a test series in which two spray systems were used in two consecutive years, was carried out with small aircraft to develop methodology for spruce budworm control.

In 1976, a concentrated sorbitol—*B. thuringiensis* (Thuricide 32B)—formulation was applied at the rate of 4.7 L/ha to a 40 ha block in a balsam fir stand averaging 30 larvae per 45 cm branch. The formulation was composed of 50 parts *B. thuringiensis* concentrate, 20 parts 70% sorbitol solution, 30 parts water, 1/1600 Chevron sticker, and 10,000 nephelometric units of chitinase/ha. A Sikorsky S-55T helicopter equipped

with four 80μm Beecomists was employed. Analyses of Kromekote cards indicated that 3.9 L/ha was depositd with an average of 25 droplets/cm^2. Droplet diameter ranged from 40 to 500 μm, peaking (41%) between 100 and 200 μm. This provided an average of 35 *B. thuringiensis* colonies/cm^2. In the treated block, larval mortality was 90%, current year defoliation was 24%, foliage protection was 72%, and loss of tree vitality was 9%. In adjacent untreated stands, where budworm populations averaged 29 larvae per 45 cm branch, larval mortality was 76%, current year defoliation was 96%, and loss of tree vitality was 95%.

In 1977, the same formulation was applied at the same rate to the same treatment block. The budworm population then averaged 20 larvae per 45 cm branch. A Grumman AgCat aircraft having a 1 135 L reservoir and equipped with a standard boom-and-nozzle spray system was employed with flat fan T8004 nozzles and a boom angle of 45°. The volume of spray deposited was 1.7 L/ha with an average of 18 droplets/cm^2. Droplet diameter ranged from 40 to 800 μm with two peaks, 27% between 200 and 300 μm and 25% between 300 and 400 μm. This provided an average of 29 colonies/cm^2.

In the block treated for the second consecutive year, larval mortality was 77%, defoliation was 36%, foliage protection was 64%, and loss of tree vitality was again 9%. In adjacent untreated stands, where budworm populations averaged 39 larvae per 45 cm branch, larval mortality was 55%, current year defoliation was 100%, and loss of tree vitality was 97%.

First-year results of a 2-year test made with several formulations and the same Grumman AgCat aircraft were similarly encouraging.

These results indicate that aerial application of *B. thuringiensis* by means of a helicopter or small planes with a standard boom-and-nozzle spray system is a valid alternative to the application of chemicals for spruce budworm control. Operational trials with medium-capacity aircraft would be required to establish the economic feasibility of such treatments for large areas.—W.A. Smirnoff, Laurentian Forest Research Centre, Sainte-Foy, Que.

FOREST PRODUCTS

Prevention of Fungal Stain on Lumber—Outdoor Screening Tests for Fungicides of Low Toxic Hazard.—This report describes outdoor tests with a series of fungicidal products identified in earlier laboratory tests as possible alternatives for the more toxic compounds now in use to prevent sapstain and mold growth on freshly cut lumber (Unligil, Forest Prod. J. 26[1]:32-33, 1976; and Forest Prod. J. in press).

The compounds tested were the agricultural fungicides Captan, Folpet, Dithane M-45, Phygon, Manzate D, G696-Thiram, and Uni 2029, and two commercial antistain products — PQ-8, containing copper 8 quinolinolate; and PQ-10, containing copper 8 quinolinolate, pentachlorophenol, and tetrachlorophenol (for chemical nomenclature, synonyms, concentration of active ingredients in the compounds, and toxicity data, see Unligil, 1976 and in press). Included for comparison was sodium pentachlorophenate (Na-PCP), a commercially used antistain chemical.

Wood samples, measuring 60 (longitudinal) × 10 × 2.5 cm and containing 70% or more sapwood, were cut from freshly converted lumber of white pine (*Pinus strobus* L.), which had been stored in the Ottawa River for 1 to 3 months prior to conversion.

Each sample was dipped for 10 s in either a 0.5% (w/v) aqueous solution or a 0.5% (w/v) suspension of the test compound, while controls were dipped in water. After draining, each sample was piled in a horizontal layer and spaced at about 5-10 mm, each layer being separated by 10 × 10 mm pine sticks (Fig. 1). Each treatment was replicated 10 or 11 times and the replicates were placed at random, each in a different layer. Two or three days after stacking, the samples were sprayed with spore suspensions of the following fungi:

(1) *Cladosporium* Link ex Fr. species,
(2) *Alternaria* Nees ex Wallr. species,
(3) *Graphium* Corda species.

Experiments were started on 15 and 26 August, 1975, in a lumberyard at Braeside, Ont., and on 5 September at the Eastern Forest Products Laboratory (EFPL) in Ottawa. Uni 2029 was used only in the Ottawa experiment. The water used in the preparation of the dipping solutions at Braeside was taken from the Ottawa River, while tapwater was used in the Ottawa (EFPL) experiment.

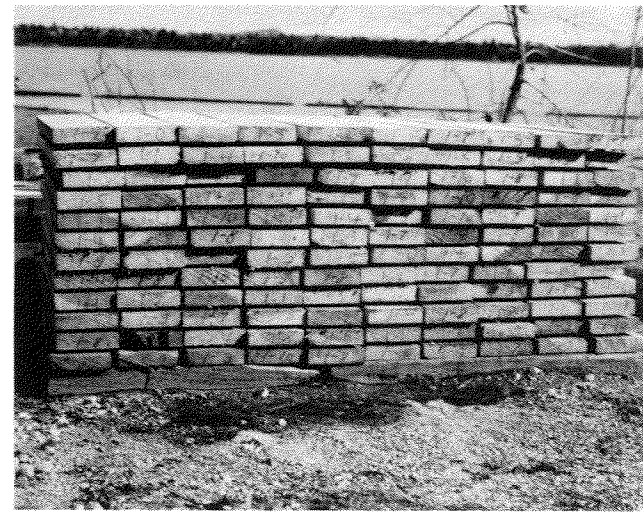


Figure 1. One of two experimental piles at termination of storage, Braeside, Ont.

TABLE 1

Results obtained from two piles built in a lumberyard at Braeside, Ont.

Compound[a]	Proportion of specimens in stain-intensity group[b, c]				
	Clean %	Light stain %	Moderate stain %	Heavy stain %	Chi-square value[d]
PQ-8	83	17	0	0	12.44^{XX}
PQ-10	88	10	2	0	9.82^{XX}
Folpet	79	19	2	0	9.82^{XX}
Na-PCP	83	12	5	0	9.82^{XX}
Captan	83	12	5	0	9.82^{XX}
Phygon	86	7	7	0	7.33^{XX}
G696-Thiram	67	26	7	0	7.33^{XX}
Dithane M-45	40	36	19	5	2.22NS
Manzate D	30	30	30	10	0.13NS
Control	41	14	19	26	—

[a] Concentration of the compounds in the dipping solution: 0.5%.
[b] Total number of specimens is 21. Ten of the specimens were tested in one pile, the remainder in the second pile.
[c] Average of two assessments carried out by different persons after air drying. Only sapwood was considered—
clean: stained area covers less than 5% of the surface,
light stain: stained area covers between 5 and 15% of the surface,
moderate stain: stained area covers between 15 and 45% of the surface,
heavy stain: stained area covers more than 45% of the surface.
[d] Chi-square test for goodness of fit was applied to rank the compounds and to compare them with the controls. For this purpose "clean" and "light stain" specimens were combined to one class, "moderate stain" and "heavy stain" specimens to a second class. The symbol xx means significant at the .01 level; NS means not significant at the .05 level.

The piles at Braeside were covered until 10 October, 1975, by polyethylene sheeting to encourage stain development. Storage was terminated on 17 October, 1975. The tops of the piles were protected from weather by a sloped plywood roof. The Ottawa EFPL piles were kept under polyethylene until 5 November.

The extent of stain on the sapwood portion of the sample was visually assessed after storage (Table 1, footnote c).

The results from both Braeside piles were similar and are presented in combined form in Table 1. Among the test compounds, PQ-8, PQ-10, Folpet, Na-PCP, and Captan rated best. Less efficient were Phygon and G696-Thiram. Dithan M-45 and Manzate D had little effect in preventing fungal stain under the test conditions. The results obtained with them were not significantly different from controls (Chi-square test).

The results obtained from the Ottawa pile (Table 2) were generally similar to those obtained at Braeside. Na-PCP, Captan, Folpet, and PQ-10 provided the best protection. G696-Thiram, Phygon, and PQ-8 were less effective. Uni 2029 (not tested at Braeside), Dithane M-45, and Manzate D

TABLE 2

Results obtained from the Ottawa pile[a]

Treatment	Proportion of specimens in stain-intensity group[b, c]: Clean %	Light stain %	Moderate stain %	Heavy stain %	Chi-square value[d]
Na-PCP	70	30	0	0	14.32^{xx}
Captan	70	30	0	0	14.32^{xx}
Folpet	85	10	5	0	11.73^{xx}
PQ-10	70	25	5	0	11.73^{xx}
G696-Thiram	35	55	10	0	10.83^{xx}
Phygon	45	40	15	0	9.76^{xx}
PQ-8	60	20	20	0	8.03^{xx}
Uni 2029	50	25	20	5	6.60^{xx}
Dithane M-45	50	25	15	10	6.60^{xx}
Manzate D	45	20	35	0	4.70^{xx}
Control	0	15	35	50	—

[a] As in Table 1.
[b] Obtained from 10 specimens tested in one pile.
[c] As in Table 1.
[d] As in Table 1.

were lower in efficiency, although they were considerably better than the controls. (All treatments are significantly different from the controls.)

Overall, Na-PCP, Captan, Folpet, and PQ-10 gave the best results. They were followed by PQ-8, G696-Thiram, and Phygon. Dithane M-45 and Manzate D were far less efficient than Phygon.

Consolidated-Bathurst Ltd., Braeside, provided wood and space for the tests, and Standard Chemical Ltd., Montreal, and Uniroyal Chemical Ltd., Elmira, Ont., provided samples of fungicides and information. M. Milot subjected the results to statistical treatment, and J.H. Vigour gave technical assistance.—H.H. Unligil, Eastern Forest Products Laboratory, Ottawa, Ont.

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