Plantation Research: VI. Hydraulic Sprayer Applications of Insecticides for Control of White Pine Weevil (*Pissodes strobi*) in Ontario, 1972

by

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INTRODUCTION

The insecticide methoxychlor is used extensively in Ontario for control of the white pine weevil (Pissodes strobi Peck) in forest plantations. Both ground sprayers and aircraft have been utilized for these applications. Howse and Sippell (1971), however, have shown that aerial applications of methoxychlor at dosages of up to 3 lb/acre (water-base sprays at 2 gal/acre) do not provide satisfactory protection.

A research project was initiated during 1971 to determine the efficacy of methoxychlor and other insecticides for the control of this important pest (DeBoo and Campbell 1971, Nigam 1972). Results of field evaluations in Simcoe County during the past year have shown that (1) methoxychlor will effectively control the weevil at rates of not more than 2 lb/acre when applied by hydraulic sprayer, (2) that timing and coverage of sprays are critical, and (3) that two other insecticides, Dursban(R) and Gardona(R), show promise as alternative spray treatments.

The project was continued during 1972 in Northumberland County to determine:

(1) The efficacy of hydraulic sprayer applications of methoxychlor at rates of 1.5 and 1.0 lb/acre.

(2) The efficacy of Dursban and Gardona sprays at 1.0 lb/acre for comparison with the 1971 rate of 0.5 lb/acre.

(3) The importance of the spray adjuvants Nu-Film-17^{R} (pinolene) and Target E^{R} as insecticide-residue extenders.

The selection of insecticides was based on the laboratory spray tower results obtained by Nigam (1972) and rates of application were determined after evaluation of the 1971 field experiments (DeBoo and Campbell 1971). The project also was designed to compliment current research in Maine on the white pine weevil and on the Sitka spruce weevil (Pissodes sitchensis Hopk.) in British Columbia.

Mention of trade names in this report is neither intentional nor indicative of exclusive endorsement by the Canadian Forestry Service.

MATERIALS AND METHODS

Treatment Area and Weevil Population Levels. Two white pine (Pinus strobus L.) plantations totalling 13.5 acres were selected for spray treatments. The plantations were located in Compartment 6 of the Northumberland County Forest, approximately 10 miles north of Cobourg. Trees averaged 10 ft. in height and numbered approximately 1,000/acre. Annual vertical growth increment was in the range of 1.5 - 2.0 ft/year. Populations of the white pine weevil had been well established for at least four years, with infested trees exceeding 20% during 1970 and 1971. Expectations were for continued severe attack during 1972.

Adult weevils were first observed feeding on April 30, 1972, but remained inactive for a period of one week thereafter due to cold temperatures.

Insecticides and Spray Adjuvants. Three of the insecticides and both adjuvants previously evaluated (DeBoo and Campbell 1971) were selected for further evaluation at the Northumberland County Forest location. These were:

(1) Dursban^{R} (0,0-diethyl O-(3,5,6-trichloro-2-pyridyl) phosphorothioate); 2.4 lb/gal. emulsifiable concentrate; supplied by Dow Chemical Co.; applied at 1.0 lb/acre in water.

(2) Gardona^{R} (2-chloro-1-(2,4,5-trichlorophenyl) vinyl dimethyl phosphate); 75% wettable powder; supplied by Shell Chemical Co.; applied at 1.0 lb/acre in water.

(3) Methoxychlor (1,1,1-trichloro-2,2-bis (p-methoxyphenyl) ethane); 25% emulsifiable concentrate; supplied by Green Cross Products; applied at 1.0, 1.5, and 2.0 lb/acre in water.

(4) Nu-Film-17^{R} (= Pinolene), (Poly-1-p Menthen-8,9-diyl); supplied by Green Cross Products; mixed with Dursban and methoxychlor sprays at 0.2 gal/acre.

(5) Target E^{R} (industrial invert disaccharide mixture with solubilizers, couplers, stabilizers, emulsifiers, and preservative); supplied by Agway Inc.; mixed with Dursban and methoxychlor sprays at 4 gal/acre.

All insecticide and insecticide-adjuvant sprays were prepared in 45-gallon batches at a central mixing station located near the white pine plantations.

Application Equipment. The C.C.R.I. experimental hydraulic sprayer used during 1971 was modified slightly to incorporate a high-pressure flowmeter for accurate determinations of emitted spray volumes (Fig.1). The sprayer system also included four 45-gallon stainless steel mixing tanks, a Wisconsin 7 HP gasoline engine with clutch, a Magikist model M.38E pump, approximately 180 ft. of high pressure delivery hose, and a John Bean Spraymaster Deluxe spray gun. The sprayer and associated equipment were mounted in a 3/4-ton pick-up truck. The central spray-mixing area included a 500-gallon water "nurse" tank and appropriate measuring and safety equipment. A weather station was located nearby (Fig.2) for between treatment readings of temperature, relative humidity and wind speed.

Experimental Design. The randomized complete block design was again employed for the spray treatments. A total of 31 plots were assigned treatments by random number. Each spray treatment included three replications of 100 trees, while four replications of 100 trees each were established as untreated check areas. Buffer strips of 50 ft. or more were established between replications (i.e. spray plots) to minimize drift problems and ensure reliability in assessments of treatment efficacy.

Spray Applications. All spray treatments were made during the period 0910-2330 hrs, May 7. Two 2-man teams alternated at approximately

2-hour intervals: one team-member operated the spray gun while the second man assisted with hose deployment, sprayer adjustments and movement of the vehicle during applications. The spray application technique was similar to that used in 1971 - the two-man crew travelled between tree rows directing the spray to the upper branch whorls only (Fig.3). Two rows were sprayed on one side during each pass away from the vehicle and two more on the opposite side on the way back. The crew then moved over two rows and continued this operation so that each tree received a double application from opposite directions for optimum spray coverage of the leader. Spraying occurred continuously with interruptions only for cleaning of the equipment and for fueling and servicing the sprayer. Two spot-lights were used for applications after dark. Weather data, collected periodically during the applications (Table I), indicated near ideal conditions for spraying.

Table I. Weather records for May 7, 1972, at the experimental spray area, Northumberland County Forest.

Time	Temp.(°F)	RH(%)	Wind(mph)	Sky
0930	47	62	2-7	overcast
1320	54	62	0-5	overcast
1530	57	48	0-8	overcast
1830	51	60	4-11	overcast
1945	45	60	0-4	partly overcast
2120	40	60	5-10	scattered cloud
2315	40	65	3-5	clear

Treatment Assessments. The incidence of leader attack was selected as the basis for evaluations of spray treatment efficacy. All trees in each spray plot (300 trees/treatment) and in the untreated check plot (total of 400 trees) were examined on August 25, 1972, and the number of weeviled leaders during both 1971 and 1972 were recorded. Differences in infestation levels were then calculated and interpreted statistically for significance (F-test, t-test) of infestation change between years and between treatments and the untreated 1972 check.

RESULTS

Applications of methoxychlor with adjuvants and without, and the Gardona sprays provided high levels of protection from attack by the white pine weevil. The Dursban treatments did not satisfactorily protect the leaders of treated trees. Pertinent information pertaining to all treatments has been summarized in Table II.

DISCUSSION

The results of the experimental spray applications at the Northumberland County Forest have shown that low dosages of short-residue insecticides will effectively control severe infestations of the white pine weevil when applied by hydraulic sprayer. As indicated in the previous report (DeBoo and Campbell 1971), timing and coverage of sprays to target trees are extremely critical factors. Weevils must be killed quickly to prevent egg deposition and subsequent feeding by the larvae (Fig.4). Brief discussions of each of the 1972 treatment follows herewith.

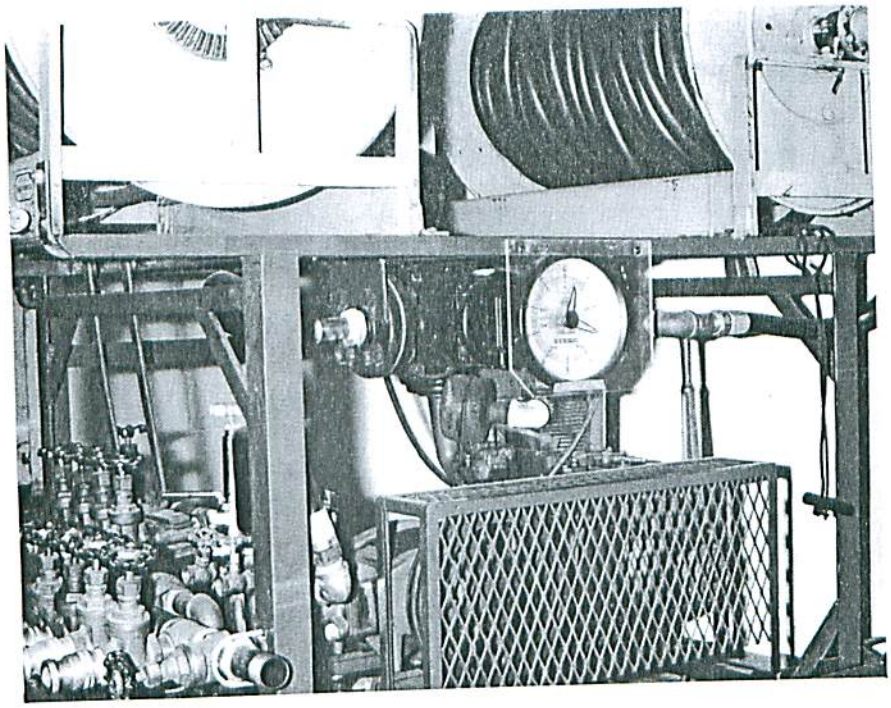

Figure 1. The Brooks oval gear flowmeter installed in the C.C.R.I. hydraulic sprayer (Photo by J. Beveridge, C.C.R.I.).

Figure 2. The weather recording station which included a tower-mounted anemometer as shown.

Figure 3. Spray application in a treatment plot.

Figure 4. Deformed white pine after several years of repeated attack by the white pine weevil.

Table II. Results of insecticide applications for control of white pine weevil at the Northumberland County Forest, May 7, 1972.

	Treatment[1]	Approx. dosage (lb. a.i.)/acre[2]	Vol. spray mix emitted (gal.)[3]	1971 No. Weeviled	1971 %	1972 No. Weeviled	1972 %	Infestation change (% Reduction)[4] Between years ('71-'72)	Infestation change (% Reduction)[4] Between trtmt. & CK ('71)
I	Methoxychlor/Target E	2.0	103	52	17	0	0	100**	100**
II	Methoxychlor/Pinolene	1.5	106	69	23	2	1	97**	98**
III	Methoxychlor	2.0	115	56	19	2	1	96**	98**
IV	Methoxychlor	1.5	119	83	28	5	2	94**	92**
V	Methoxychlor	1.0	96	61	20	5	2	92**	92**
VI	Gardona	1.0	108	79	26	6	2	92**	91**
VII	Dursban/Target E	1.0	148	70	23	20	7	71**	69**
VIII	Dursban	1.0	119	77	26	30	10	61**	53**
IX	Dursban/Pinolene	1.0	93	79	26	49	16	38 n.s.	23 n.s.
X	Untreated Check	-	-	88	22	85	21	3 n.s.	-

1 Ranked according to efficacy.

2 Target E @ 4 gal.; Pinolene @ 0.2 gal.

3 As calculated for 1 acre with 1,000 - 10 ft. trees; variations in volumes due to differences in tree stocking.

4 As expressed by number of weeviled leaders.

** Difference significant at 1% level.

n.s. Difference not significant.

Dursban. Results of applications of Dursban at 1 lb/acre (treatments VII, VIII, IX) did not differ appreciably in reducing weevil population levels from those levels attained by applications at 0.5 lb. during 1971. Unsatisfactory protection of leaders resulted from all three treatments, although statistically-interpreted, significant reductions were attained by the Dursban-Target E sprays. The same formulation of the insecticide was used as in 1971, and the ineffectiveness of the increased dosage cannot be explained. It is suspected, however, that this insecticide may be too short-lived to span the oviposition phase of the adult activity period.

Gardona. The increased concentration of Gardona (treatment VI) at 1 lb/acre provided excellent control of the weevil. The effect of this single application was similar to results obtained from two spaced applications of 0.5 lb/acre during 1971, and was more than three times as effective as a single application of 0.5 lb.

Methoxychlor. Each of the methoxychlor treatments (III-V) provided excellent protection of the white pines against weevil attack. The highest dosage of 2 lb/acre (treatment III) gave the best results, but the lower dosages of 1.5 lb. (treatment IV) and 1.0 lb. (treatment V) provided very satisfactory protection also. The results obtained at the Northumberland location corroborated those conclusions based on the previous applications in Simcoe County: methoxychlor is an effective insecticide for the control of the white pine weevil when applied by hydraulic sprayer at not more than 2 lb/acre. When timed to coincide with the commencement of the adult activity period during late-April and early-May, upwards of 100% protection of the leaders may be expected.

Nu-Film-17 (Pinolene). The addition of this adjuvant to Dursban (treatment IX) and methoxychlor (treatment II) sprays produced divergent control results. Contrary to the indications from the 1971 applications, the addition of Nu-Film-17 to Dursban sprays did not provide increased protection of leaders when compared to straight water-based applications of this insecticide (treatment VIII). In fact, more than twice as many leaders were destroyed in the 1972 treatment plots than after similar applications during 1971 with only half the concentration of the insecticide (e.g. 7% of the trees infested after treatment during 1971, 16% after treatment in 1972). These results tend to support the supposition that, even with the addition of an effective residue extender, some non-persistent insecticides may be too short-lived and therefore unsuitable for control of the weevil. The spray results obtained when this adjuvant was added to methoxychlor sprays, on the other hand, were more than twice as effective as the comparable insecticide/water treatment (e.g. II vs. IV). Also, the addition of Nu-Film-17 to methoxychlor sprays at 1.5 lb. a.i./acre indicated that excellent control of the weevil may be achieved with lower concentrations of this insecticide. The 1972 results indicated that this treatment (II) was as effective as the treatment at 2 lb/acre (III).

Target E. A new formulation of this adjuvant was used in the 1972 applications. Significant levels of leader protection were achieved when Target E was added to both methoxychlor (treatment I) and Dursban sprays (treatment VII). The methoxychlor/Target E applications constituted the most

effective of the 1972 treatments. It was evident that this adjuvant also might permit reduced dosages of methoxychlor (i.e. at 1 or 1.5 lb/acre) to be consistently as effective as at the rate of 2 lbs. The new formulation appeared to be highly superior to that used in 1971.

Both methoxychlor and Gardona have LD_{50} dermal toxicity values in the range of 5,000-7,000 mg/kg (Kenaga and Allison 1971) and qualify amongst the least hazardous synthetic insecticides currently available. Preliminary analyses of results of a related project[1] have indicated the chemical half-life of methoxychlor sprays on white pine bark to be approximately 26 days. It is suspected that the residual persistence of Gardona on pine bark may be even shorter. Thus, dilute applications of either insecticide, when timed to span the greater proportion of the adult activity period (e.g. May 1-20 in southern Ontario), appear to qualify as a safe and effective treatment for control of the white pine weevil. Additional large-scale field evaluations and appropriate monitoring of possible deleterious side-effects to non-target organisms should be undertaken prior to wide-scale adoption and recommendation of either treatment.

The results obtained with the Dursban sprays at 1.0 lb/acre were no better that those obtained at 0.5 lb. during 1971. The addition of adjuvants did not appreciably improve this treatment. Further experimentation would be required to fully evaluate the potential efficacy and practicability of Dursban for control of the weevil.

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1 Sundaram, K.M.S. 1972. A preliminary report on the persistence of methoxychlor for the control of white pine weevil in plantations. (manuscript in preparation)

Current research on other insecticides for the control of curculionid leader weevils have yielded promising results (H. Trefts, Maine Forestry Department; S. Ilnytzky, Pacific Forest Research Center, personal communication). It may be expected then, that new recommendations will be available shortly for applications by ground sprayers. At present, not one insecticide is registered specifically for control of white pine and Sitka spruce weevils in Canada (Chemical Control Research Institute 1972).

The problem inherent to aerial applications of methoxychlor appears to be more definable now, and apparently looms as one of inadequate spray coverage rather than insufficient insecticide. The results of preliminary comparisons of spray volumes and formulations during a companion field study[2] indicate this to be the case.

SUMMARY AND CONCLUSIONS

1. Applications of Gardona (1.0 lb/acre) and methoxychlor (1.0, 1.5 lb/acre) provided excellent protection of leaders of white pines from attack by the white pine weevil. Applications of Dursban (1.0 lb/acre) did not effectively control the weevil.
2. Methoxychlor and Gardona sprays with the adjuvants Target E and Nu-Film-17 constituted the most effective treatments of the 1972 series. It was apparent that additives in the extender-spreader-sticker category might greatly improve dilute sprays of certain short-residue insecticides.

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[2] DeBoo, R.F. and L.M. Campbell. 1972. Plantation Research: VII. Experimental aerial applications of methoxychlor for control of white pine weevil in Ontario, 1972. (manuscript in preparation)

3. Hydraulic sprayer applications of methoxychlor at spray volumes of about 100 gal/acre provided the coverage essential for white pine weevil control. Since concentrations of the insecticide at 1 to 2 lbs. in this volume effectively protected trees, it was indicated that insufficient spray deposit, and not inadequate amounts of the insecticide, might account for the unacceptable levels of protection achieved by aerial applications in Ontario during the period 1969-1971.
4. The results of this project, along with those from similar studies in Maine and British Columbia, indicate that a choice of safe and effective weevil control recommendations for ground treatment should be available in the very near future.

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