

Plantation Research: IX. Chemical Control of Pine  
Needle Scale, Phenacaspis pinifoliae  
(Fitch) (Homoptera: Diaspididae), in  
Christmas Tree Plantations

by

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Chemical Control Research Institute  
Canadian Forestry Service  
Ottawa Ontario  
Information Report CC-X-42

August, 1973

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Plantation Research: IX. Chemical Control of Pine

Needle Scale, Phenacaspis pinifoliae (Fitch)

(Homoptera: Diaspididae), in Christmas Tree

Plantations<sup>1</sup>

by R.F. DeBoo and J.A. Weidhaas, Jr.<sup>2</sup>

INTRODUCTION

The pine needle scale, Phenacaspis pinifoliae (Fitch), is a well known pest of ornamental and plantation conifers having an extensive distribution in North America (Baker 1972, Peterson and DeBoo 1969). The insect is primarily of economic importance in the production of Scots pine (Pinus sylvestris L.) Christmas trees in eastern North America, in white spruce (Picea glauca (Moench) Voss), Colorado spruce (P. pungens Engelm.) and Scots pine shelterbelts in the prairie regions, and in Douglas-fir (Pseudotsuga menziesii (Mirb.) Franco) stands in the West.

Three types of damage occur from infestation of young coniferous hosts:

- (1) Unsightliness due to the large numbers of whitish scales (Fig. 1, 2) and chlorosis of the foliage;
- (2) Reductions in shoot and needle elongation;

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1 - This report is based on research conducted by the authors while at Cornell University, Ithaca, N.Y.

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(3) Loss of needles, mortality of branches and whole trees after sustained attack for three or more years. In addition, eggs under drying scale coverings on foliage of Christmas trees placed indoors often fall and accumulate on gifts underneath causing a unique aesthetic problem: When the gift packages are handled, both wrappings and fingers become smudged with the purplish pigment of the succulent eggs.

The life history and habits of the pine needle scale in New York State have been studied by the authors, Nielsen (1970) and others. Briefly, the insect overwinters in the egg stage under the protection of the female scale covering. First generation crawlers are active for a period of several days usually during the third or fourth week of May in Upstate areas. Dispersal to new feeding sites on the one-year-old foliage occurs at this time. Individuals of the first generation mature in July, eggs are deposited under the scale covering, and crawlers again emerge during the last week of this month. Crawlers of this second generation move to the new branch tips where they settle on the foliage. Maturity is reached towards late August and September, and eggs are once again deposited to overwinter. Infestations are usually most abundant within the lower crowns of young trees, but as the infestation persists the crown may become completely covered.

In New York, serious infestations of the pine needle scale have occurred during the past decade in northern counties along Lake Ontario (Fig. 3). Because of climatic and geographic conditions, two generations occur annually in this region, whereas the insect may be



univoltine in other areas of the state (Herrick 1930) and in Canada (Peterson and DeBoo 1969). The occurrence of severe infestations of this bivoltine population has had particularly serious effects on the production of quality Scots pine Christmas trees in the region by curtailing the harvesting of marketable trees during several of the peak attack years.

Investigations for the control of pine needle scale infestations by application of synthetic organic insecticides were carried out from 1963 to 1965 under the auspices of the New York State Agricultural Experiment Station at Cornell University. During this period, the insect was considered to be one of the most important pests of ornamentals and plantations in the state. The investigations were conducted primarily to determine economical methods of control using the most readily available insecticides and application equipment.

Although not previously published, the data in this report were presented orally at meetings of the New York State School for Christmas Tree growers and at annual meetings of the New York State Pesticide Conference held at Cornell University, Ithaca, N.Y. This report, then, is presented primarily to supplement the more recent findings by Nielsen and Johnson (1972) in New York for persons currently engaged in pesticide evaluation and recommendation. Certain of the insecticides (e.g. DDT) and dosages evaluated obviously may be of little value under current restrictive legislation on pesticide usage in both Canada and the United States. Most, however, presently have extensive label registration for use on trees and woody shrubs. The data, therefore may also be of value to industry in the support of usage claims and for the promotion of control research on this and

other related insect pests of coniferous trees. Currently, only malathion is registered for control of pine needle scale in Canada (Chemical Control Research Institute 1973), whereas applications of malathion, dimethoate, 60- or 70- second oil, and oil plus ethion are recommended control measures in New York (Saunders 1972).

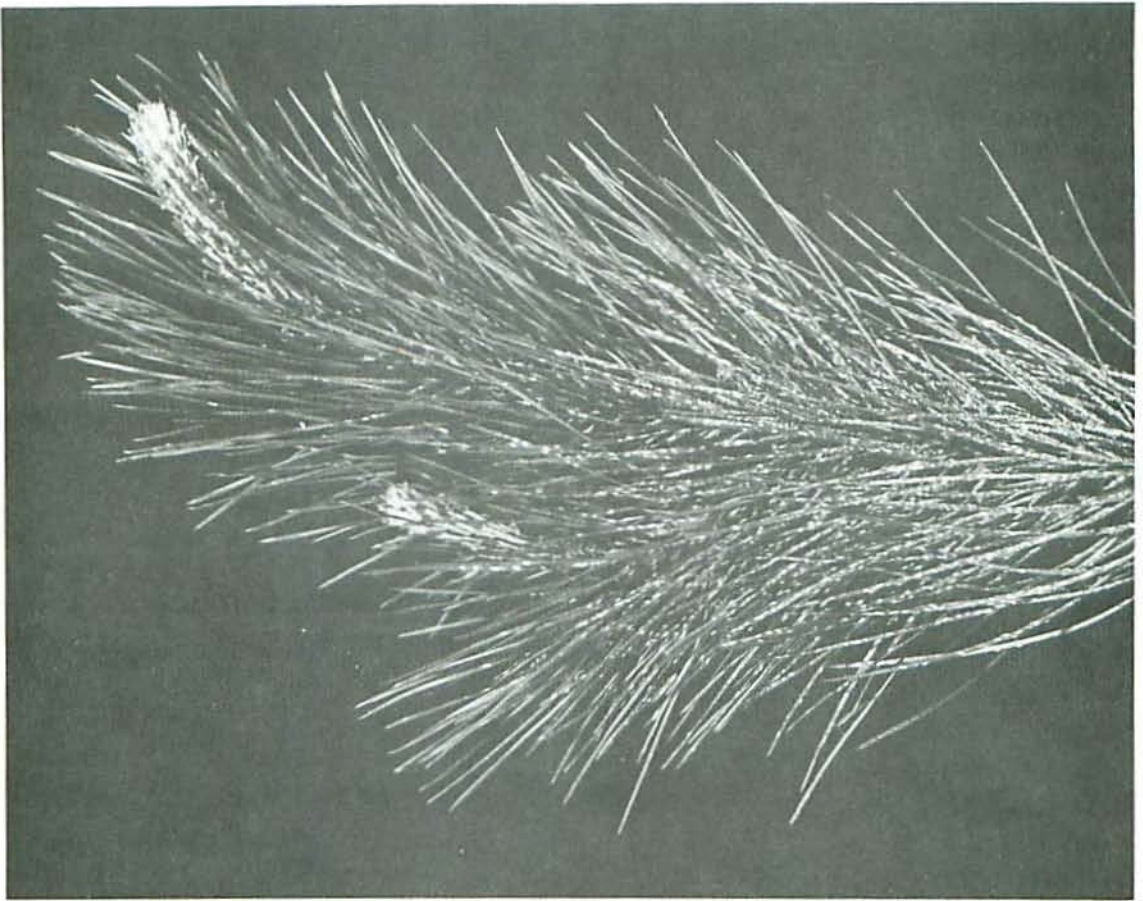


Fig. 1. Severe infestation of pine needle scale on Scots pine foliage.

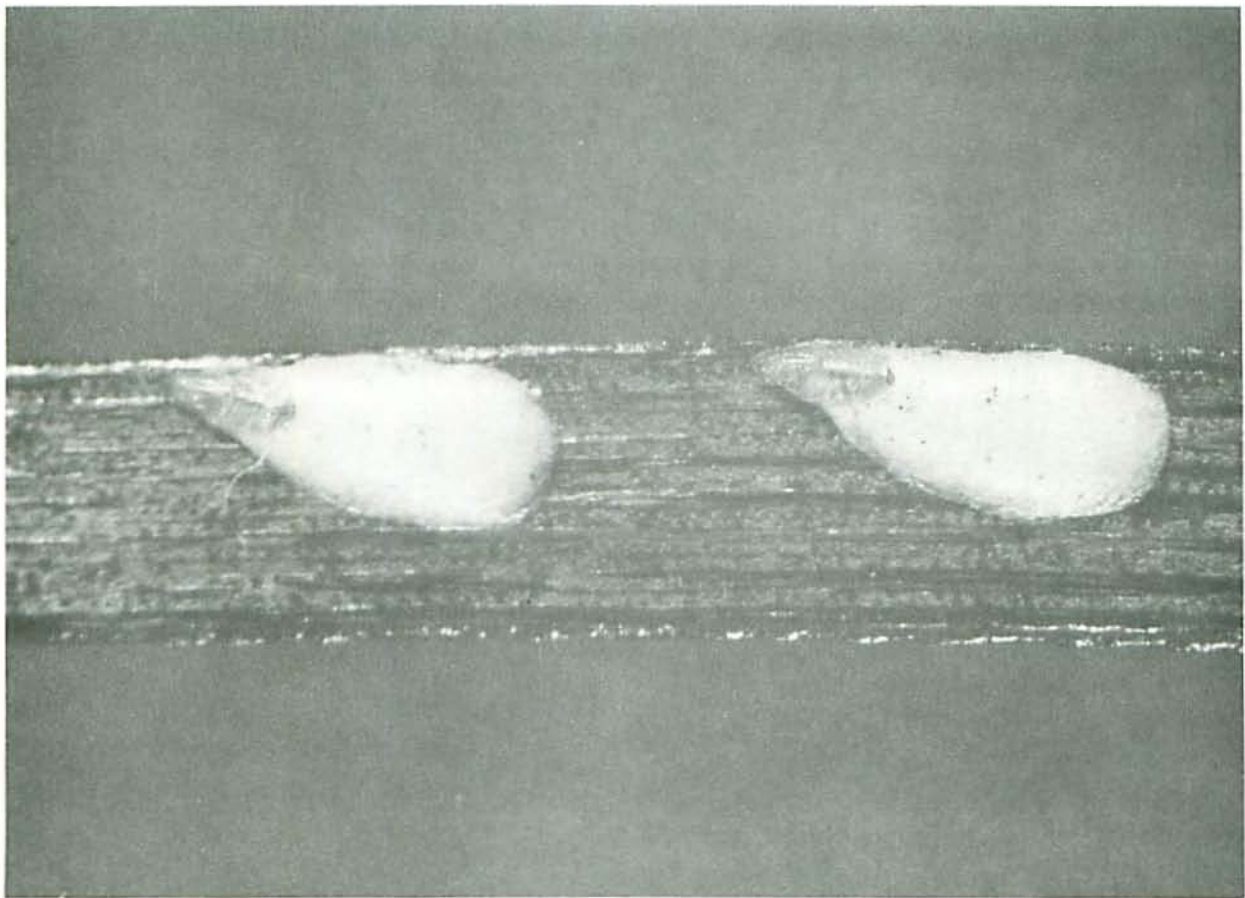


Fig. 2. Mature pine needle scales on pine needle.



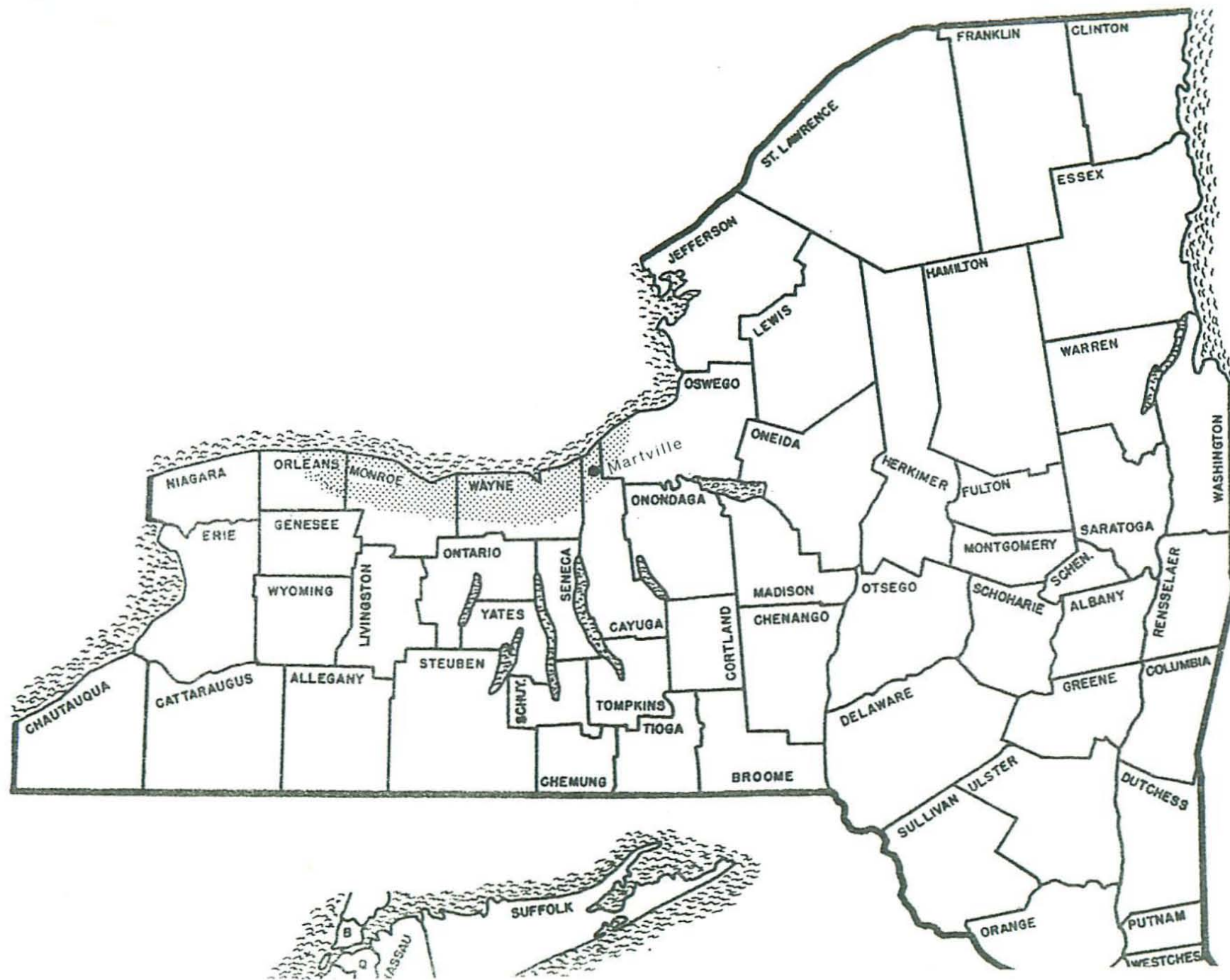


Fig. 3. Distribution of severe infestations of pine needle scale (hatched area) in New York, 1960-1965

### MATERIALS AND METHODS

Two Scots pine plantations (total area about 50 acres), near the village of Martville in Northern Cayuga County, were selected for the control treatments. Most of the trees present were 4 to 6 feet in height, but sizes ranged from one-foot seedlings to 12 feet because of selective harvesting of Christmas trees and continuous annual restocking.

A preliminary survey showed that pine needle scale infestations on individual trees ranged from very light to extremely high densities in both plantations. Three categories of infestation were established for the investigation:

- I Light - for trees with scales present on only a few branches of the lower crown quarter,
- II Moderate - for trees with abundant scales on most of the lower half of the crown,
- III Severe - for trees with abundant scales throughout the whole crown.

Utilizing this classification, only trees 4 to 6 feet in height with moderate or severe infestations were selected for treatment.

Several treatments and methods of application were evaluated during the course of the study. Emulsifiable concentrates, used for foliar sprays were applied with a Kiekens knapsack mistblower, a Kiekens knapsack compressed-air sprayer and a gasoline-powered, high-pressure hydraulic sprayer equipped with delivery hose and spray gun as small-block replicated treatments (3 replicates of 10 trees/treatment). A single large block (10 acres) of trees was selected for aerial spray treatment.

The airspray was applied with a Piper PA18A Supercub equipped with a 32-foot boom having 12 D8 nozzles. Care was taken to achieve uniform coverage of trees in all groundspray plots, and flagmen were employed to guide the pilot of the aircraft to ensure uniform deposit of the small droplets emitted at heights of 5 to 10 feet above treetops in swaths of 50 feet.

Treatments of systemic insecticides for root-uptake were applied either as water-emulsion drenches, utilizing the compressed-air sprayer or as granulars utilizing graduated one-pint ice cream cartons with perforated bottoms for even distribution beneath tree crowns. The area treated extended one foot beyond the crown spread of each tree. Thirty trees, 3 replications of 10 trees in a randomized block design, were used for each soil treatment.

Insecticides selected for treatment are listed in Table I. Formulations and application rates are given in Tables II-XII accompanying the results section of this report. Spray volumes for groundsprays (foliage and soil) were calibrated to fall within the range of 90-150 U.S. gallons/acre. Mistblower applications were at approximately 50 gal. of spray mixture/acre; the aerial spray was emitted at 4 gal./acre. Granular insecticides were sprinkled over the ground litter at rates of 2 to 4 oz. of formulated product per inch of basal tree diameter.

Treatment application throughout the study was timed to coincide with certain developmental stages of the pine needle scale in the region. Oils and mixtures of oils and insecticides were applied as dormant sprays against the overwintering eggs and the first generation (spring) crawlers. Oils also were applied against the second



generation (summer) crawlers and eggs. Water-base sprays were timed to coincide with peak crawler activity of both generations of the scale. Certain treatments made in 1964 with a compressed-air sprayer were applied one week before and again one week after peak crawler activity to further evaluate the importance of timing. Systemic insecticides, used as aerial and soil treatments, also were applied to yield information on the role of timing.

Sampling for assessment of all treatments applied with ground equipment first involved the selection of three representative branches from each treated or untreated check tree. Thirty needles were then selected randomly from each branch; thus a total of 90 needles were examined on each tree giving a grand total of 2700 needles examined per treatment and untreated check plot. Sampling for evaluation of the aerial application was similar. Because of the larger area treated, three groups of 10 trees were selected from the spray block for comparison with a similar number of untreated trees. Again, examinations of 2700 needles for live scale insects from each area formed the basis for treatment evaluation. The data were subjected to statistical analyses (F-tests, t-test) for systematic appraisal of all results.



Table 1. Insecticides selected for experimental application, 1963-1965.

<u>Insecticide</u>	<u>Chemical Designation</u>	<u>LD<sub>50</sub> Dermal (mg/kg)<sup>1</sup></u> <u>(R=rats; Rb=rabbits)</u>
carbaryl (Sevin <sup>R</sup> )	1-naphthyl methylcarbamate	R >012->4000 Rb >22-66
carbophenothion (Trithion <sup>R</sup> )	S-[p-chlorophenylthio)methyl] 0,0-diethyl phosphorodithioate	R 1931-3263
DDT	1,1,1-trichloro-2,2-bis (p-chlorophenyl)ethane	R 1931-3263 Rb 2820
demeton (Systox <sup>R</sup> )	mixture of 0,0-diethyl S-(and 0)-2-[(ethylthio)ethyl] phosphorodithioates	R 8-200 Rb-24
diazinon	0,0-diethyl 0-(2-isopropyl-4-methyl-6-primidyl) phosphorodithioate	R 379-1200 Rb 4000
dimethoate (Cygon <sup>R</sup> )	0,0-dimethyl S-(N-methylcarbamoylmethyl phosphorodithioate	R <150-1150
dimetilan	1-(dimethylcarbamoyl)- 5-methyl-3-pyrazolyl dimethylcarbamate	R 600->2000
disulfoton (Di-Syston <sup>R</sup> )	0,0-diethyl S-2-[(ethylthio)ethyl] phosphorodithioate	R 20-50
ethion	0,0,0 <sup>1</sup> , 0 <sup>1</sup> -tetraethyl S,S <sup>1</sup> -methylenebisphosphorodithioate	R 915-1600 Rb 515-1620
malathion	diethyl mercaptosuccinate, S-ester with 0,0-dimethyl phosphorodithioate	R >4000->4444 Rb 4100
oxydemtonmethyl (Meta-Systox-RR)	S-[z-(ethylsulfinyl)ethyl] 0,0-dimethyl phosphorodithioate	R 100-250
phosphamidon (Dimecron <sup>R</sup> )	2-chloro-N,N-diethyl-3- hydroxycrotonamide, dimethyl phosphate	R 125-150 Rb 267
superior petroleum oils (60-, 70-, 80- sec.)		

<sup>1</sup> After Kenaga and Allison (1971).

## RESULTS AND DISCUSSION

The results of the chemical treatments, arranged in chronological sequence, are presented in Tables II to XII. Brief discussions of results grouped according to timing and mode of application follow herewith:

Late Dormant Sprays for Control of Overwintering Eggs and First-Generation Crawlers: Applications of superior oils, oil + carbophenothion, and diamethoate (Tables II, IV) were made primarily to obtain mortality of overwintering eggs and hatching crawlers from the overwinter population. Good population suppression was obtained with the dimethoate, 70-sec oil, and 60-sec oil + ethion treatments in 1963 (Table II), but satisfactory results were not achieved with any treatment in 1964 (Table IV). Subsequent operational applications of oils and oil + insecticides in New York, however, indicate these to be effective scale-control treatments and those results obtained in 1964 to be atypical. The failure of the 1964 treatments cannot be explained.

Oil Emulsion Sprays for Control of Second-Generation Scales: Foliar applications of a superior oil and oil + insecticide mixtures to prevent infestation of new foliage by migrating scale crawlers were applied in late July, 1964 (Table XI). All treatments were highly effective in reducing population levels of the scale as extensive mortality of both eggs and crawlers occurred. Also, no phytotoxicity to treated foliage was noted, thereby indicating that oil emulsions at the concentrations evaluated were non-injurious after hardening of the new foliage had occurred. The results also indicated that two applications

of oil or oil + insecticide emulsions timed as late dormant and mid-summer sprays might effectively contain scale increase and spread and possibly eradicate moderate and severe infestations.

Water Emulsion Sprays by Compressed-Air and Hydraulic Sprayers:

Evaluations of treatments applied by compressed-air sprayer (Tables V, VI, VII) clearly demonstrated the importance of timing. Of the insecticides used, the malathion + DDT mixture gave consistent and good control, even when applied approximately one week after peak crawler activity (Table VII). The relative ineffectiveness of a late application of malathion (Table VII), when compared with results with a properly timed spray (Table V), was clearly evident. Applications of carbaryl and dimethoate gave good control regardless of the time applied, but not to the same degree as obtained with the malathion + DDT treatments. Diazinon gave best results when applied twice (Table VI). The overall effectiveness of these treatments on population densities of the subsequent second generation of the scale could not be assessed adequately due to complications caused by predation by large numbers of the twice-stabbed lady-beetle, Chilocorus stigma (Say)<sup>3</sup>. Population levels on treated trees, however, generally remained lower than on corresponding untreated check trees.

Similar foliar applications of most of these 10 spray treatments by gasoline-powered hydraulic sprayer for control of the second-generation

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<sup>3</sup> DeBoo, R.F. and J.A. Weidhaas Jr. Studies on the predation of pine needle scale, Phenacaspis pinifoliae (Fitch), by the coccinellid, Chilocorus stigma (Say). Manuscript in preparation.



population provided excellent protection of trees (Table X). Scale populations were virtually eradicated with malathion, malathion + DDT and carbaryl treatments. The remnant but small numbers of live scales found on trees after treatment with the other chemicals were mostly located between the basal portions of needle pairs, and thus may have survived in part by this protection from direct contact of the sprays.

In general, results clearly indicated that proper timing of sprays is an important consideration for application of most of the selected insecticides, and that two applications (spring, summer) may be advisable where immediate suppression of severe infestation of bivoltine populations is warranted.

Water Emulsion Sprays by Knapsack Mistblower. Knapsack mistblower sprays of the same insecticides applied by compressed-air sprayer generally induced greater population reduction (Tables VIII, IX). The malathion + DDT treatment again resulted in superior reduction (100%), but all treatments caused more than 95% reduction in second-generation levels. The more efficient dispersal of the small spray droplets was considered to be the most important factor in the high degree of success experienced with this machine.

Aerial Application of a Systemic Insecticide: The aerial application of dimethoate was unsuccessful as the post-treatment abundance levels of the scale population increased at all sampling locations within the treatment block (Table III). Although spray deposit measurements were not made, it was suspected that distribution of droplets may have been inadequate on the target trees. Also at the time of application, settled second-stage nymphs had commenced to secrete their waxy coverings, thereby providing protection from the contact effect of the insecticide.



Systemic activity (in terms of biological observations made) was not indicated. The population of pine needle scale, established on the one-year-old foliage, was probably less susceptible to localized systemic action (i.e. within a needle) than had it occurred on the new and physiologically more active current-year foliage.

Soil Treatments: Applications of emulsifiable and granular formulations of systemic insecticides beneath trees gave some evidence of control. As in the case of the aerial application of dimethoate, this series of treatments (Table XII) was designed specifically for late (i.e. post-crawler) application. Results were inconclusive, however, as very heavy natural predation by C. stigma again masked actual spray impact. Observations of surviving scale populations did show the effects of pesticide translocation as 100% mortality occurred on foliage of certain branches, whereas other branches immediately above or below these harbored many living scale insects. Overall, only the soil drench with disulfoton had significant visible and statistical impact on first-generation levels, while the lady-beetle predation prevented analysis of treatment effect on the subsequent generation.

Table II. Late dormant foliar applications of insecticides by compressed-air sprayer for control of first-generation pine needle scale, May 14, 1963.

Treatment and formulation used	Amt/100 gal water	Ave. No. live scales/needle			Population Reduction (%)		
		2nd gen 1962	1st gen 1963	2nd gen 1963	1st gen 1963	2nd gen 1963	2nd gen 1963(corrected)
Dimethoate, 23% EC	1 gal	11.6	0	0.7	100	94	93 **
70 sec. oil	2 gal	14.5	1.6	1.2	89	92	90 **
60 sec. oil + 4% ethion	2 gal	13.0	0	1.4	100	89	87 **
70 sec. oil + 2% ethion	2 gal	10.6	2.5	3.7	76	65	58 **
60 sec. oil + 2% ethion	2 gal	7.2	2.1	3.0	71	58	49 **
Untreated Check	--	13.8	10.7	11.5	22	17	---

\*\* Reduction significant at 1% confidence level.

Note: For all tables, efficacy of treatment is based on differences between population densities of 2nd (summer) generation adults and infestation-originating adults of the preceeding year. Corrected percent reductions are included to show actual mortality due to treatment (Abbott 1925).

Table III. Aerial application of a systemic insecticide, dimethoate, for control of first-generation pine needle scale, June 17, 1963, (water emulsion @ 1.25 lb. active/ac; total of 4 gal. spray mixture/acre).

Treatment	Replication	Ave. No. live scales per needle			Population Reduction (%)		
		2nd gen 1962	1st gen 1963	2nd gen 1963	1st gen 1963	2nd gen 1963	2nd gen 1963(corrected)
Dimethoate sample group A	1	12	35	47	0	0	0
	2	13	29	47	0	0	0
	3	16	28	77	0	0	0
Dimethoate sample group B	1	12	24	49	0	0	0
	2	15	32	37	0	0	0
	3	16	27	31	0	0	0
Untreated check	1	11	28	47	-	-	-
	2	11	32	68	-	-	-
	3	17	28	13	-	-	-

Table IV. Late dormant foliar applications of insecticides by compressed-air sprayer for control of first-generation pine needle scale. May 25, 1964

Treatment and formulation used	Amt. per 100 gal. water	Ave. No. live scales per needle			Population Reduction (%)		
		2nd gen. 1963	1st gen 1964	2nd gen. 1964	1st gen. 1964	2nd gen 1964	2nd gen 1964(corrected)
60 sec. oil + 2% ethion	2 gal.	12.4	10.9	21.7	12	0	0
60 sec. oil + 4% ethion	2 gal.	15.1	15.7	17.7	0	0	0
70 sec. oil + 2% ethion	2 gal.	8.9	15.9	19.0	0	0	0
86 sec. oil + 45% carbophenothion	2 gal.	6.4	2.4	16.5	63	0	0
86 sec. oil	2 gal.	8.1	1.5	11.2	81	0	0
Untreated check	--	10.6	8.9	8.3	16	22	-



Table V. Applications of insecticides by compressed air sprayer for control of first-generation pine needle scale, May 17, 1964.

Treatment and formulation used	Amt. per 100 gal. water	Ave. No. live scales per needle			Population Reduction (%)		
		2nd gen. 1963	1st gen. 1964	2nd gen. 1964	1st gen 1964	2nd gen 1964	2nd gen 1964 (Corrected) <sup>1</sup>
Malathion, 57% EC + DDT 25% EC	2 qts + 1 gal.	17.4	0.3	0.4	98	98	94 **
Malathion, 57% EC	2 qts	16.4	7.4	1.2	55	93	80 **
Carbaryl (Sevin 4-Flow)	2 qts	12.9	2.9	1.4	78	89	69 **
Dimethoate, 23% EC	2 qts	13.8	2.5	1.7	82	88	66 **
Diazinon, 25% EC	2 qts	13.6	1.6	2.3	88	83	51 **
Untreated Check	-	18.5	19.3	6.5	0	65	--

1 - Actual percent reduction confounded due to predation by C. stigma.

Table VI. Applications of insecticides by compressed-air sprayer for control of first-generation pine needle scale, May 17 and May 31, 1964

Treatment and formulation used	Amt. per 100 gal. water	Ave. No. live scales per needle			Population Reduction (%)		
		2nd gen. 1963	1st gen. 1964	2nd gen 1964	1st gen. 1964	2nd gen. 1964	2nd gen. 1964(Corrected) <sup>1</sup>
Diazinon, 25% EC	2 qts	13.6	0.1	0.2	99	99	98 **
Malathion, 57% EC	2 qts	16.4	0.1	0.4	99	98	96 **
Malathion, 57% EC + DDT, 25% EC	2 qts + 1 gal.	17.4	0.1	0.5	99	97	93 **
Carbaryl (Sevin 4-Flow.)	2 qts	12.9	0.1	0.7	99	95	89 **
Dimethoate, 23% EC	2 qts	13.8	1.1	1.5	92	89	76 **
Untreated Check	-	9.3	17.9	4.3	0	54	--

<sup>1</sup> Actual percent reduction confounded due to predation by C. stigma.

Table VII Applications of insecticides by compressed-air sprayer for control of first-generation pine needle scale, May 31, 1964.

Treatment and formulation used	Amt. per 100 gal. water	Ave. No. live scales per needle			Population Reduction (%)		
		2nd gen. 1963	1st gen. 1964	2nd gen 1964	1st gen. 1964	2nd gen. 1964	2nd gen. 1964 (Corrected) <sup>1</sup>
Malathion, 57% EC + DDT, 25% EC	2 qts + 1 gal.	17.4	0.1	0.2	99	99	98 **
Dimethoate, 23% EC	2 qts	13.8	3.6	0.7	74	95	92 **
Carbaryl (Sevin 4-Flow)	2 qts	12.9	3.2	1.1	75	91	85 **
Diazinon, 25% EC	2 qts	13.6	0.5	2.9	96	79	66 **
Malathion, 57% EC	2 qts	16.4	0.2	4.1	99	75	59 **
Untreated check	-	16.6	27.5	10.2	0	39	--

<sup>1</sup> Actual % reduction confounded due to predation by C. stigma.

Table VIII. Applications of insecticides by knapsack mistblower for control of first-generation pine needle scale, May 31, 1964.

Treatment and formulation used	Amt. per 100 gal. water	Ave. No. live scales per needle			Population Reduction (%)			1
		2nd gen. 1963	1st gen. 1964	2nd gen. 1964	1st gen 1964	2nd gen 1964	2nd gen. 1964(Corrected)	
Malathion, 57% EC + DDT, 25% EC	2 qts + 1 gal	17.9	0.01	0.01	99	99	99 **	
Malathion, 57% EC	2 qts.	21.8	0.03	0.04	99	99	99 **	
Dimethoate, 23% EC	2 qts.	22.9	0.1	0.2	99	99	98 **	
Diazinon, 25% EC	2 qts.	14.8	0.1	0.2	99	99	98 **	
Carbaryl (Sevin 4-Flow.)	2 qts.	12.2	0.1	0.3	99	98	95 **	
Untreated check	-	20.5	38.9	8.7	0	58	--	

<sup>1</sup> Actual % reduction confounded due to predation by C. stigma.



Table IX. Applications of insecticides by knapsack mistblower for control of second-generation pine needle scale, July 29, 1964.

Treatment and formulation used	Amt. per 100 gal. water	Ave. No. live scales per needle			Population Reduction (%)		
		2nd gen. 1963	1st gen. 1964	2nd gen. 1964	1st gen. 1964	2nd gen. 1964	2nd gen. 1964(Corrected) <sup>1</sup>
Malathion, 57% EC + DDT, 25% EC	2 qts. + 1 gal	20.2	36.2	0.0	--	100	100
Malathion, 57% EC	2 qts.	17.8	24.5	0.2	--	99	99
Dimethoate, 23% EC	2 qts.	13.9	19.6	0.6	--	96	96
Diazinon, 25% EC	2 qts.	15.1	21.6	0.6	--	96	96
Carbaryl (Sevin 4-Flow.)	2 qts.	17.7	20.3	0.8	--	95	95
Untreated check	--	17.0	29.2	16.7	--	2	--

<sup>1</sup> Actual % reduction confounded due to predation by C. stigma.

Table X. Applications of insecticides by hydraulic power sprayer for control of second-generation pine needle scale, July 28, 1964.

Treatment and formulation used	Amt. per 100 gal. water	Ave. No. live scales per needle			Population Reduction (%)		
		2nd gen. 1963	1st gen. 1964	2nd gen. 1964	1st gen. 1964	2nd gen 1964	2nd gen. 1964(Corrected) <sup>1</sup>
Malathion, 57% EC + DDT, 25% EC	2 qts + 1 gal	16.5	30.2	0	--	100	100
Malathion, 57% EC	2 qts	16.8	16.3	0	--	100	100
Carbaryl (Sevin 4-Flow)	2 qts	12.1	27.5	0	--	100	100
Disulfoton, 50% EC	1 gal	17.7	37.8	0.01	--	99	99
Dimeton, 25% EC	1 gal	9.8	20.0	0.01	--	99	99
DDT, 25% EC + Triton 100 (Surfactant)	1 gal + 6 oz.	14.2	21.3	0.02	--	99	99
Carbofenothion, 45% EC	1½ gal	11.7	17.1	0.04	--	99	99
Phosphamidon, 49% EC	2 qts	14.5	29.6	0.4	--	95	95
Dimethoate, 23% AC	2 qts	13.6	25.4	0.7	--	65	62
Diazinon, 25% EC	2 qts	11.0	19.9	3.9	--	9	--
Untreated Check	--	15.1	33.6	13.7			

<sup>1</sup>  
- Actual reduction confounded by predation by C. stigma.

Table XI. Oil and oil + insecticide applications by hydraulic power sprayer for control of second-generation pine needle scale, July 28, 1964.

Treatment and formulation used	Amt. per 100 gal. water	Ave. No. live scales per needle			Population Reduction (%)		
		2nd gen. 1963	1st gen. 1964	2nd gen. 1964	1st gen. 1964	2nd gen. 1964	2nd gen. 1964 (Corrected) <sup>1</sup>
70 sec. oil	2 gal	9.7	16.5	0.01	--	99	99
70 sec. oil + ethion, 2% EC	2 gal	15.2	24.9	0.04	--	99	99
60 sec. oil + ethion, 2% EC	2 gal	15.0	23.7	0.2	--	99	99
60 sec. oil + ethion, 4% EC	2 gal	18.8	22.0	0.3	--	99	99
Untreated check	-	11.2	20.3	30.5	--	0	0

<sup>1</sup> - Actual % reduction confounded due to predation by C. stigma.

Table XII. Soil treatments with systemic insecticides for control of first-generation pine needle scale, June 9, 1965.

Treatment and formulation used	Amt./100 gal. water	Ave. No. live scales per needle			Population Reduction (%)		
		2nd gen. 1964	1st gen 1965	2nd gen. 1965	1st gen. 1965	2nd gen. 1965	2nd gen. 1965(Corrected) <sup>1</sup>
Dimetilan, 10% gran.	(4 oz/in. diam)	10.0	3.4	1.3	-	99	89
Dimethoate, 23% EC	2 pt	9.8	6.2	0.6	-	94	44
Disulfoton, 10% gran.	(4 oz/in diam)	17.2	16.0	0.1	-	89	0
DiSyston, 66% EC	2 pt	11.3	15.2	3.2	-	87	0
Disulfoton, 10% gran.	(2 oz/in. diam)	7.0	11.9	1.7	-	79	0
Demeton, 26% EC	2 pt	6.1	11.4	0.7	-	76	0
Oxydemetonmethyl, 25% EC	2 pt	7.3	15.0	1.5	-	72	0
Untreated check	--	25.4	7.5	2.2	-	91	-

<sup>1</sup> - Actual % reduction confounded due to predation by C. stigma.



### SUMMARY AND CONCLUSIONS

The pine needle scale control experiments conducted in upstate New York from 1963 to 1965 clearly demonstrated that protection of trees from serious infestation is possible with certain readily available and environmentally acceptable insecticides. Timely applications by groundspray equipment virtually eradicated the scale from current year foliage in certain instances. The experiments showed that foliar treatments with conventional manually operated or gasoline powered sprayers produce the best results because of the complete coverage possible by careful application to individual trees.

Applications of certain systemic insecticides as soil treatment for root uptake showed some promise as an alternative to foliar sprays. Distribution of the insecticides within trees was uneven, however, as certain branches remained heavily infested after treatment while others were found to be scale-free. Possibly shallow trenching and watering-in of the systemics would have resulted in better translocation patterns and subsequent distribution within tree crowns.

The aerial application of a systemic insecticide was the least effective of the methods tried. The indifferent results obtained were obviously due to the poor deposition and distribution of the spray on trees. The authors consider aerial spray applications for control of the scale to be feasible, but that considerable research input is still required for effective results to be obtained. The obvious pathway lies with certain of the more sophisticated atomizing spray emission equipment now available.

#### ACKNOWLEDGEMENTS

The authors wish to express their sincere thanks to Cornell University for permission to publish the data in the Information Report Series of publications of the Canadian Forestry Service; to Mrs. Aija Thayer and Mr. Michael Kerr, student assistants during the course of the project; to Messrs. Ed LaRock and M. Van Sanford for permission to conduct the spray experiments in their plantations; to the manufacturers and distributors of the insecticides evaluated for supplying quantities for the experiments; to Dr. W.T. Johnson, Cornell University, for providing photographs of the Scale (Fig. 1, 2); to Messrs. W.W. Hopewell and L.M. Campbell, C.C.R.I., and L.O.T. Peterson, formerly entomologist at the P.F.R.A. Tree Nursery at Indian Head, Sask., for their valuable comments in the review of the manuscript.

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